THE EAST AFRICAN AGRICULTURAL JOURNAL

Issued under the Authority of the East African Governors' Conference and published every three months—July, October, January, April. Volume consists of four issues (commencing July issue).

Editor: Director, East African Agricultural Research Station, Amani.
Editorial Board: Directors of Agriculture, Kenya, Tanganyika, Uganda, and Zanzibar.
Assistant Editors: R. E. Moreau, Amani; Mrs. Holmes Jackson, Department of Agriculture, Nairobi.

FOREWORD

Readers of the *Journal* will agree that this number is of great and exceptionally varied interest, so much so that it is more difficult than usual to select contributions for mention. A noteworthy feature is the number of short articles on immediately practical subjects, such as emergency dips, the making of acetic acid, the use of substitute trek-chains, the preservation of fence posts. Mr. Elmer's article recommends hedge-plants that will save any fence posts at all. The increased importance of wheat is recognized by articles on its phosphatic manuring and on "take-all" disease.

Most of the main articles also have a practical bias. Dr. French brings together in a convenient form the information on the feeding value of East African fodders, actual and potential, that has been amassed in many years' work at Mpwapwa. The wealth of accurate detail now made available will, we are sure, astonish many readers.

Mr. Liversage's article on "Marginal Costs" is lively and very much to the point. To us it is doubly refreshing. For one thing we have an economist admitting something we have always felt in our bones: namely, that, however necessary simple accounts may be, cost-accounting applied in detail to farming is bunk. For another thing he has done what more important people than ourselves are beginning to see is a crying need: he has discussed a complicated subject simply, forcefully and with every-day examples. How much of a success, or how much of a mess, we make of the new world depends in great measure on how well honest men, who know, learn to say what they know, and say it fearlessly.

Another closely practical article written in the good tradition is that of Mr. Harris on "Termites and Buildings". As with other pests and diseases, success in prevention and control can be expected only if the enemy to be fought is properly identified. Mr. Harris has given aids to this in an earlier article (Vol. 6 (4) pp. 201–205). With that and the detailed recommendations he now makes, no permanent building need in future be put up in East Africa that has not an excellent chance of remaining termite-proof.

Major Joyce, in his article on Ethiopia and its agriculture, deals with a subject on which many of us must have felt curious. A remarkable feature, on which he comments in a later part, is the absence of soil erosion and the excellent native practices. "The Ethiopian farmer is erosion minded." Good luck to him: since there is also no shortage of land he has a long start towards prosperous farming.

Mr. Gilman's review of the Mpwapwa experiments calls attention to a series of original investigations, the findings of which, if confirmed by similar work in other areas, must revolutionize some of the older ideas held on land utilization and on water supplies. Much of Africa is too poor for agriculture; consequently development will largely depend on making the best use of pastoral areas. It is to be hoped that enough money will be provided for research on this all-important subject in the post-war years.

The use of natural and secondary vegetation as an indicator of the agricultural value of land is a long-established practice. Mr. Thomas in his article goes further and points out that much useful information on soils and climate can be gained by studying the kinds of food crops grown and the methods of cultivation employed. In passing, Mr. Thomas enumerates the number of major food crops in East Africa which are not indigenous. To the primitive agriculturists of the Americas we owe such staples as maize, cassava, potatoes and sweet potatoes.

In this number are illustrations with reference to the article "Native Agricultural Implements in the Uganda Protectorate", appearing on pages 96 to 100 of the October *Journal*. The illustrations were received too late for inclusion in the October *Journal*.

CORRIGENDUM

In Vol. 8 No. 2 (October, 1942) p. 68. Fig. 2, *for* 27-11-42 *read* 27-11-41.

THE COMPOSITIONS AND NUTRITIVE VALUES OF TANGANYIKA FEEDING STUFFS

By M. H. French, M.A., Ph.D., Dip. Agric. (Cantab.) (Veterinary Laboratory, Mpwapwa, Tanganyika Territory)

Animal husbandry in the tropics is still in its infancy but, like all vigorously developing and healthy infants, it has already abandoned many unprofitable exploratory avenues which once seemed attractive. The science is making rapid headway and so, backed by the knowledge and experience gained by previous workers, it is easy to criticize the often erroneous ideals and efforts of the pioneers and, though I refer to past erroneous hypotheses, it is only to show their bearing on recent Tanganyika work.

All Colonial animal husbandry ventures are directed towards the improvement of the existing live stock and, since this effort is governed and judged by the standards attained in better developed temperate countries, improvement comes to mean an increase in quality and productivity (meat, milk, eggs, wool, etc.). There are two main avenues of approach, (*a*) to breed up and improve local live stock by selection within the breed, and (*b*) to get quicker results by crossing the local stock with imported animals which excel in the qualities it is desired to improve. Both methods have been tried, but it was not at first realized that it is futile to try to improve stock without, first of all, improving the environmental conditions (disease position, plane of nutrition and management). Much progress has now been made in combating disease problems, but much still needs to be done in improving the plane of nutrition. First and foremost, if the larger farm live stock are to be kept, is the need to improve the natural grazing [1] and then to study how additional supplementary foods can be best and most economically used.

When a new settler first meets unfamiliar colonial conditions there is much that he must do before he can hope to develop a successful live stock farming enterprise. He is most fortunate if he can take over an already developed farm and it is more usual for him to have to create pastures from rough, unsuitable grazings or even to have to cut down thicket, bush or forest to establish the necessary pasturage. Even if he can start immediately to improve his grazings it will take time before the fruits of his labours are repaid by his animals, and in the intervening period he will have to feed his stock supplementary foodstuffs. A number of the latter are unfamiliar and of unknown feeding value, but I do not think the situation is as bad as might be inferred from the following extract from an editorial in *Tropical Agriculture* [2]:—

> "Even for the most commonly used tropical fodders and concentrated foods, digestibility coefficients derived from experiments with tropical animals in tropical countries are still generally lacking. So also are determinations of the maintenance and production requirements of tropical stock. Apart from a few figures of this kind which have been ascertained and published in India, all one can do in regard to tropical animals is to make guesses based on figures that were derived from experiments with temperate climate breeds in temperate conditions, making guessed adjustments for the difference in the average weights of the breed. For many tropical foods that are quite commonly used no digestibility coefficients are available at all."

The information on the compositions and feeding values of tropical feeding stuffs is, however, rapidly being increased and many published analyses are not widely known because they have appeared in Annual Reports or other periodicals that are not much read. One of the objects of this paper is to bring together a large number of digestibility trials that have been carried out and published during the last ten years in Tanganyika.

The original trials, with relevant notes and discussions, can be found scattered through the Annual Reports of the Department of Veterinary Science and Animal Husbandry, Tanganyika Territory, since 1931. These digestibility trials were carried out with either mature native oxen or sheep, under Tanganyika conditions, on locally produced feeding stuffs and, in the first instance, they apply directly only to East African conditions. If, however, the compositions of these foodstuffs are compared with the analyses collected by

the Imperial Bureau of Animal Nutrition [3] from other parts of Africa, it is seen that the Tanganyika foodstuffs, whilst they vary slightly, do not differ in any significant manner from those in other African territories. Similarly, in those cases where it is possible to make a comparison, the Tanganyika foodstuffs do not vary in any unpredictable manner from the compositions published by Henry and Morrison [4] for American foodstuffs, nor from those tabulated by Wood and Woodman [5] for British feeding stuffs. This is more true for concentrate foods than for roughages, but even the Tanganyika roughages, though they may show lower protein contents, have analytical compositions which are of the same order as the same roughages grown in other similar climates. This Tanganyika experience suggests that, if there are no local analyses of supplementary concentrate foods, a farmer will not go very far wrong if he takes the average values of analyses made in other parts of the world. It must always be remembered, when searching for foodstuff compositions, that the same food will vary slightly in composition between different localities of any given territory. and also between seasons for the same locality.

On the other hand there are often large differences between the compositions of typical Tanganyika fodders and typical temperate region roughages, because the high fibre contents of Tanganyikan fodders have few parallels in the temperate region fodders. Here again, it has to be remembered that digestibility values are not fixed constants but may vary from one animal to another, and also in the same animal if examined at different times.

As the number of trials made in Tanganyika increased it seemed that, generally, the difference was not large between the digestibility coefficients found for tropical animals and those from temperate areas. A direct comparison of the digestive powers of local Zebu oxen and ¾-grade Ayrshires for feeding stuffs varying from highly nutritious concentrates to coarse fibrous fodders was then made [6] and the results showed that high-grade animals in Tanganyika did not differ significantly from local Zebu cattle in their powers of digesting local foodstuffs under Tanganyika conditions. From this work it appears that, in the majority of cases, digestibility coefficients determined in one country can be utilized by farmers in another without any great errors arising, provided that the foodstuffs are grown under the same environmental conditions in both territories. Also, digestibility values obtained with European animals are sufficiently accurate for tropical use.

This is a most important point and one which is not generally recognized. In fact there are suggestions in the literature that the digestive powers of Zebu cattle are higher than those of high-grade or pure-bred European animals, e.g. Matson [7] states that: "The European ox extracting 60 per cent from 30 lb. dry matter is inferior *in India* to the Indian ox, which can only digest 20 lb. dry matter but extracts 75 per cent". Warth and Gossip [8] found that their Zebus gained weight when the ration supplied only bare maintenance requirements if judged by European standards. In the same way, Sayer [9] concluded that European feeding standards were unsuited to Indian cows and concluded that the latter had a "different digestive capacity". Warth [10] also suggested that Indian Zebus had higher digestive powers than European cattle, but in none of these cases was a direct comparison made between European cattle and Zebus under the same conditions. I imagine that these *suggested* superior digestive powers of Zebus and also the repeated stress laid by other authors on the lack of analytical data and accurate feeding values for tropical foodstuffs, arose when it was first realized that Zebu cattle could thrive and reproduce in tropical conditions which were unsuited to high-grade or pure-bred European animals. The many instances of constitutional failure and low productivity in the latter group of animals were naturally attributed to faulty nutrition, particularly as the local animals could do well under hard conditions on which imported animals would die. It is now known [11] [12] that it is not merely a question of nutrition; a host of other factors (all of which are not yet known) are involved; but it was not unnatural for nutrition to be blamed in the early days.

Productive feeding values are dependent on both the crude compositions and the digestibilities of feeding stuffs. It is not surprising, therefore, to find from the tables at the end of this article that those calculated for Tanganyika concentrates are of the same order and nutritive ratio as those listed by Wood and Woodman [5] and by Kellner [13]. For the coarser foods direct comparison is not possible, but the local roughages usually have wider nutritive ratios owing to their lower contents of digestible protein.

The published nutritive values of American, British and European feeding stuffs are the averages from many trials, whereas the following Tanganyika figures are computed from only one or two trials. So from what has already been said about variations in composition and digestibility coefficients, too much emphasis must not be placed on small differences between the starch-equivalent values of Tanganyika foodstuffs and the more authenticated averages published elsewhere. The science of nutrition has made such rapid progress this century that too often starch equivalent and digestible nutrient values are regarded as exact constants instead of flexible biological estimates which are, at their best, only convenient practical guides.

From the digestibility trials carried out in Tanganyika and from my experience in feeding farm live stock I believe that, for practical rationing purposes, there is no significant difference between the feeding values (starch equivalents) of the same concentrates whether grown in the tropics or in temperate regions. For the coarse fodders, however, it is not possible to judge the feeding values of tropically grown roughages from the nutritive values of fodders grown in temperate regions. Yet in spite of this conclusion I realize that it is not possible in the tropics either to ration stock correctly or to understand the nutritional differences between tropical and European animals until much more information is available concerning (*a*) the nutritional requirements of indigenous animals and (*b*) the differences between tropical and European animals in their powers of *assimilating* digested nutrients.

This article has stressed the nutritional factors in tropical animal husbandry and it is perhaps necessary to warn farmers that there are many adverse climatic and environmental factors militating against success. Even when they are correctly fed, the productivity of pure-bred and too highly graded European animals under tropical conditions will decline and constitutional failures occur. The full benefits of correct nutrition will not be obtained with such animals until more is known of these environmental factors and how they are to be overcome. Much progress has already been made in this direction and three recent papers from different parts of Africa [14] [15] [16] indicate the urgency of these problems and the last paper illustrates the importance of fully understanding the meaning of the word "tropical conditions" in connexion with live stock problems. Mere residence in tropical latitudes does not mean that the animals are under tropical conditions. Altitude considerably modifies the climatic conditions and it is possible that high altitude (such as Kenya) enables live stock to do well.

In the tables I have given the data for ruminants and for pigs separately, partly for easy reference and partly because the pig data were obtained on European pigs but under local conditions. As would be expected, the pig-feeding values follow closely the corresponding figures from other parts of the world, and their interpretation is not clouded by differences in breed and type between Tanganyika and temperate conditions such as happens with cattle or sheep.

REFERENCES

[1] French, M. H. (1941).—*Emp. J. Exp. Agric.* 9. 23.

[2] Editorial (1941).—*Trop. Agric.* 18. 21.

[3] Imp. Bur. Animal Nutrition (1936).—*Tech. Comm.* No. 6.

[4] Henry, W. A., and Morrison, F. B. (1928).—*Feeds and Feeding*, 19th Ed.

[5] Wood, T. B., and Woodman, H. E.—*Rations for Live Stock*, 8th Ed.

[6] French, M. H. (1940).—*J. Agric. Sci.* 30. 503.

[7] Matson, J. (1928-9).—*J. Cent. Bur., Anim. Husbandry and Dairying*, India 2. 83.

[8] Warth, F. J., and Gossip, F. J. (1930).—*Mem. Dept. Agric.*, India 10. 1.

[9] Sayer, W. (1934).—*Agric. and Live Stock*, India 4, 105.

[10] Warth, F. J. (1927-8).—*J. Cent. Bur. Anim. Husb. and Dairying*, India 1, 122.

[11] Carneiro, G. G., and Rhoad, A. O. (1936).—*Trop. Agric.* 13. 177.

[12] French, M. H. (1937).—*An. Rep. Dept. Vety. Sci.*, Tanganyika, p. 65.

[13] Kellner, O. (1926).—*The Scientific Feeding of Animals*, 2nd English Ed.

[14] Bonsma, J. C. (1940).—*Farmg. S. Africa*, 15, 373.

[15] French, M. H. (1941).—*E. Afric. Agric. J.* 6. 189.

[16] Daubney, R. (1942).—*E. Afric. Agric. J.*, 7, 127.

THE COMPOSITION AND NUTRITIVE VALUE OF TANGANYIKA FEEDING STUFFS
I.—FIGURES FOR RUMINANTS

	Number of trials	Normal dry matter	Dry Matter Composition						Digestible Nutrients				Starch equivalent	Nutritive ratio	Animals used in trials
			Crude protein	Ether extract	N-free extract	Crude fibre	Total ash	Silica (SiO_2)	Crude protein	Ether extract	N-free extract	Crude fibre			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1. Roots and Tubers															
Cassava Tubers	2	20	3·6	1·0	85·4	5·0	5·0	1·2	0·7	0·9	81·9	3·9	88·1	1:125	Sheep
Edible Canna Tubers	1	30	3·6	0·8	84·8	3·4	7·4	N.D.	1·6	0·5	76·1	3·0	81·5	1: 50	Sheep
Sweet Potato Tubers	1	30	5·1	1·1	87·5	2·8	3·5	0·4	1·9	0·6	83·9	2·2	89·0	1: 45	Sheep
2. Leaves of Above															
Edible Canna Tops	1	18	10·2	5·1	48·5	19·7	16·5	4·1	4·5	1·4	32·0	6·9	34·3	1: 7	Sheep
Sweet Potato Tops	1	17	16·0	5·6	23·3	45·0	10·1	—	—	—	—	—	—	—	—
3. Grasses															
Mixed Grasses (Flowering)	1	25	8·4	3·0	46·5	31·0	11·1	5·7	5·0	1·6	25·1	18·5	33·3	1: 9	Sheep
Mixed Grasses (Mature)	2	30	8·0	1·8	43·4	34·8	12·0	N.D.	4·0	1·1	19·7	18·4	23·8	1: 10	Oxen
Andropogon caricosus (leaves 12″ and stems 24″, flowering)	1	28	7·0	1·5	43·1	36·7	11·7	7·7	3·8	1·0	28·8	28·6	41·6	1: 16	Sheep
Cenchrus ciliaris Type B. 2½ ft. early flowering	1	25	8·5	1·8	41·6	36·9	11·2	6·2	5·6	2,1	30·6	29·8	48·3	1: 12	Sheep
C. ciliaris Type D. 1–1½ ft. early flowering	1	20	11·0	2·6	41·3	31·9	13·2	6·0	8·2	2·2	30·1	24·3	47·7	1: 7	Sheep
C. ciliaris Type D. 2½ ft. early flowering	1	25	11·1	2·0	40·0	34·6	12·3	4·7	8·2	2·8	29·1	27·1	49·2	1: 8	Sheep
Chloris gayana 1–1½ ft. Few inflorescences–first cut	1	20	9·5	1·7	44·5	32·5	11·8	5·3	6·6	0·8	34·6	27·2	50·5	1: 10	Sheep
Chloris gayana 1–1½ ft. Few inflorescences–second cut	1	25	7·1	1·0	43·0	38·7	10·2	5·7	4·4	0·3	27·2	28·8	38·2	1: 13	Sheep
Cynodon plectostachyum 8–12″ no flowering heads	1	20	19·1	2·9	42·4	22·6	13·0	5·5	15·3	1·4	29·6	15·8	49·1	1: 3	Sheep
C. plectostachyum 1–1½ ft. Few inflorescences	1	28	11·0	1·3	46·0	30·3	11·4	5·9	8·1	0·3	29·0	18·2	37·9	1: 6	Sheep
C. plectostachyum 2 ft. Early flowering	1	30	11·0	2·0	45·2	30·2	11·6	4·8	8·1	0·7	24·2	19·3	35·0	1: 6	Sheep
Digitaria Pentzii 4–6″ no flower heads	1	20	14·0	3·0	40·3	28·4	14·3	8·0	11·7	2·3	32·5	23·4	54·8	1: 5	Sheep
Digitaria Pentzii 6–9″ few flowering heads	1	28	8·7	1·9	45·9	31·7	11·8	5·5	5·3	0·7	33·4	24·4	45·7	1: 11	Sheep
Digitaria Pentzii 10–12″ early flowering	1	30	6·7	2·3	44·3	35·2	11·5	7·4	3·7	1·3	26·7	25·1	37·4	1: 15	Sheep
Leerzia hexandra 6–10″ not flowering	1	30	10·1	1·8	52·1	25·6	10·4	5·8	7·0	0·6	37·4	15·6	45·9	1: 8	Sheep
Panicum maximum Type B. 1–1½ ft. not flowering	1	25	8·8	1·6	48·5	29·9	11·2	4·2	5·7	0·5	32·5	21·4	42·8	1: 10	Sheep
Panicum maximum Type B. 2½–3 ft. not flowering	1	25	8·8	1·5	44·0	32·8	12·9	4·9	3·8	0·2	26·3	24·1	35·4	1: 13	Sheep
Panicum maximum Type B. leaves 4 ft. early flowering heads 6 ft.	1	28	5·3	1·4	43·1	39·6	10·6	5·3	2·7	0·7	23·0	25·3	29·2	1: 18	Sheep
Paspalum dilatatum, few inflorescences first growth	1	25	6·7	1·6	48·4	31·8	11·5	6·9	3·3	0·9	35·7	24·6	46·7	1: 19	Sheep
Paspalum dilatatum, leaves 1 ft., few inflorescences, second growth	1	30	6·2	1·5	50·1	31·9	10·3	6·6	3·3	0·8	38·0	24·4	48·5	1: 20	Sheep
Pennisetum purpureum, 1–1½ ft. not flowering	1	20	9·8	2·6	43·9	29·7	14·0	5·5	6·0	1·3	31·5	22·2	44·6	1: 9	Sheep
Pennisetum purpureum, 2½–3 ft. not flowering	1	20	9·0	1·1	46·5	28·6	14·8	5·9	4·9	0·5	28·9	17·3	35·2	1: 10	Sheep
Pennisetum purpureum up to 8 ft. early flowering	1	25	7·2	1·0	43·3	36·1	12·4	7·6	3·6	0·3	22·9	21·7	27·7	1: 13	Sheep
4. Green Cereals															
Maize, cobs milky, 6–7 ft.	1	17	8·8	0·9	54·8	28·1	7·4	2·3	5·0	0·2	39·9	18·7	47·4	1: 11	Sheep
Miller, seed forming, 6–7 ft.	1	20	7·6	1·5	50·5	32·6	7·8	3·2	4·3	1·0	32·4	22·2	41·7	1: 13	Sheep
Bulrush millet, flowering heads emerging, 4–6 ft.	1	15	13·7	1·7	42·2	27·5	14·9	6·0	9·1	0·8	29·9	20·3	44·5	1: 6	Sheep
5. Green Legumes															
Lucerne, dry season growth, early flowering	1	30	19·4	2·7	48·1	21·0	8·8	0·5	14·3	0·8	34·2	5·3	42·4	1: 3	Sheep
Lucerne, wet season growth, early flowering	1	25	18·4	2·3	45·0	25·5	8·8	0·1	13·5	0·2	32·1	12·7	43·1	1: 3	Sheep
Lucerne, wet season growth, budding	1	30	20·6	2·4	42·3	24·9	9·8	0·6	16·5	0·3	33·7	13·2	48·6	1: 3	Sheep

	Number of trials	Normal dry matter	Dry Matter Composition						Digestible Nutrients				Starch equivalent	Nutritive ratio	Animals used in trials
			Crude protein	Ether extract	N-free extract	Crude fibre	Total ash	Silica (SiO_2)	Crude protein	Ether extract	N-free extract	Crude fibre			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
6. Silage															
Mixed grass silage, cut for hay but spoilt by rain, then ensiled	1	21	7·5	3·5	41·8	36·9	10·3	5·8	3·7	2·2	16·3	20·8	21·4	1: 11	Sheep
Mixed grass silage, ensiled immediately after cutting	1	18	9·6	2.6	36·6	36·3	14·9	8·8	4·8	1·8	19·7	23·3	29·0	1: 10	Sheep
Maize silage, crop ensiled and fed whole	1	20	6·2	2·4	52·7	31·9	6·8	0·0	1·2	1·2	23·8	12·5	33·1	1: 31	Oxen
Maize silage, crop ensiled whole but fed in 18″ lengths	1	20	6·2	2·4	52·7	31·9	6·8	0·0	1·2	1·5	28·2	13·8	37·6	1: 39	Sheep
Maize silage, crop ensiled whole but fed in 9″ lengths	1	20	7·5	1·9	53·0	31·4	6·2	0·0	2·6	1·3	39·6	22·6	55·1	1: 25	Oxen
Maize silage, crop chaffed before ensiling	1	18	6·5	3·3	53·3	31·9	5·0	0·0	2·4	2·6	32·9	20·2	49·4	1: 26	Sheep
Panicum maximum silage, chaffed	1	20	6·3	2·7	31·7	39·7	19·6	12·2	2·2	1·1	16·4	32·7	40·1	1: 24	Sheep
7. Hay															
Mixed grasses—First growth	1	88	7·5	2·1	43·0	36·7	10·7	5·8	4·0	1·2	21·7	22·3	39·5	1: 11	Sheep
Mixed grasses—First growth	1	88	8·8	2·2	44·3	34·5	10·2	6·6	5·5	1·3	26·7	23·3	37·6	1: 10	Oxen
Mixed grasses—Aftermath growth	3	89	8·5	1·7	45·9	34·2	9·7	5·4	4·8	0·9	22·3	19·0	30·9	1: 10	Sheep
Mixed grasses—First growth in droughty year	1	90	7·5	1·5	44·0	35·6	11·4	6·5	4·1	0·7	28·0	19·5	31·6	1: 13	Sheep
Mixed grasses-Aftermath growth in droughty year	1	90	5·4	1·3	50·8	33·5	9·0	4·8	1·8	0·5	23·4	18·5	25·1	1: 25	Sheep
Mixed grasses—Whole seasons growth	1	90	6·1	1·2	46·9	33·5	12·3	8·2	1·6	0·4	21·6	17·8	22·5	1: 25	Sheep
Chiefly *Cynodon plectostachyum*—First growth	1	88	10·5	1·6	46·3	31·4	10·2	4·6	6·1	0·3	28·0	19·7	35·8	1: 8	Oxen
Chiefly *Cynodon plectostachyum*—Aftermath growth	1	89	8·0	3·6	45·0	33·4	10·0	5·7	3·7	2·4	22·0	18·3	29·0	1: 12	Oxen
Chiefly *Cynodon plectostachyum*—Whole season's growth	1	90	7·3	1·0	45·9	37·1	8·7	4·0	3·8	0·1	21·7	19·9	23·7	1: 11	Oxen
Chiefly *Cynodon plectostachyum*—Allowed to dry in situ and cut in middle of dry season	1	91	5·2	0·9	46·1	39·7	8·1	3·8	1·2	0·2	23·7	15·9	19·8	1: 34	Oxen
Andropogon caricosus hay, first growth	1	88	6·1	1·7	40·1	40·3	11·8	8·0	2·8	1·1	19·1	24·7	25·3	1: 16	Sheep
Cenchrus cilaris Type B hay, first growth	1	88	6·9	1·1	42·8	37·2	12·0	6·9	3·2	0·4	24·2	25·1	31·4	1: 16	Sheep
Cenchrus cilaris Type D hay, first growth	1	87	7·4	1·7	44·0	35·2	11·7	8·0	4·0	0·8	29·7	25·2	39·7	1: 14	Sheep
Chloris gayana hay, first growth	1	87	3·7	1·3	42·8	43·5	8·7	5·0	1·2	0·6	21·8	24·6	23·4	1: 40	Sheep
Chloris gayana hay, aftermath growth	1	87	3·7	1·2	44·4	42·0	8·7	5·3	1·2	0·5	20·7	23·3	21·4	1: 39	Sheep
8. Legume Hay															
Cowpea hay	1	88	13·0	1·7	36·3	37·7	11·3	4·1	7·9	0·7	25·4	25·1	48·4	1: 5	Oxen
Cowpea hay	1	88	12·9	2·7	46·8	29·5	8·1	1·1	8·7	1·7	35·6	13·1	43·1	1: 6	Sheep
Fiwi bean hay (*Dolichos lablab*)	1	86	11·7	2·2	39·5	37·7	8·9	2·0	6·9	1·3	25·6	19·1	30·9	1: 7	Sheep
Groundnut tops	1	87	7·8	1·0	49·6	31·7	9·9	5·6	3·8	0·3	39·2	14·6	48·8	1: 15	Sheep
Lucerne hay	1	88	16·5	2·0	38·1	31·4	12·0	1·1	10·7	0·3	24·8	13·7	30·7	1: 4	Sheep
Velvet bean hay, made without loss of leaves and seeds	1	86	17·9	2·6	46·3	23·8	9·4	3·5	10·9	1·8	37·8	14·3	51·9	1: 5	Sheep
Velvet bean hay, made with much loss of leaves and seeds	1	89	13·0	1·8	40·0	33·7	11·5	3·7	7·1	1·2	25·2	18·1	32·6	1: 6	Sheep
9. Stovers															
Maize stover	1	88	5·0	1·1	52·5	34·7	6·7	2·6	2·5	0·8	34·4	24·6	29·5	1: 24	Oxen
Millet stover	1	88	4·3	1·2	47·0	37·2	10·3	5·3	1·3	1·1	26·4	23·0	24·8	1: 36	Oxen
Bulrush millet stover	1	88	4·3	0·9	41·9	43·6	9·3	0·6	0·6	0·4	20·0	25·0	21·7	1: 68	Oxen
10. Tree and Bush Leaves															
Banana plants (Whole plant)	1	5–10	6·4	0·8	56·0	23·7	13·1	1·8	3·5	0·5	47·6	12·7	57·5	1: 18	Sheep
Banana leaves	1	15	8·2	3·2	47·1	29·8	11·7	—	—	—	—	—	—	—	—
Banana plant trunks	1	5	2·7	0·6	65·8	17·4	13·5	—	—	—	—	—	—	—	—
Disperma trachyphyllum, dried mature leaves	1	89	8·4	2·4	47·2	16·2	25·8	20·2	2·4	0·8	24·1	3·8	26·0	1: 12	Sheep
Disperma trachyphyllum, young green leaves	1	28	13·0	2·7	52·6	13·4	18·3	11·1	—	—	—	—	—	—	—
Ficus sycamorus	1	30	13·5	2·1	54·7	14·3	15·4	6·0	2·5	1·2	31·0	4·6	32·0	1: 15	Sheep

THE COMPOSITION AND NUTRITIVE VALUE OF TANGANYIKA FEEDING STUFFS
I.—FIGURES FOR RUMINANTS—(*Cont.*)

	Number of trials	Normal dry matter	Dry Matter Composition						Digestible Nutrients				Starch equivalent	Nutritive ratio	Animals used in trials
			Crude protein	Ether extract	N-free extract	Crude fibre	Total ash	Silica (SiO_2)	Crude protein	Ether extract	N-free extract	Crude fibre			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
11. Tree Seeds and Fruits															
Acacia albida pods and seeds	1	90	8·8	1·5	61·7	24·4	3·6	0·3	4·5	1·0	46·2	4·0	48·3	1: 12	Sheep
Acacia arabica pods and seeds	1	90	12·9	2·5	63·8	15·2	5·6	0·4	6·7	2·2	50·4	3·2	66·3	1: 9	Sheep
Acacia spirocarpa pods and seeds	1	90	12·6	1·8	57·9	22·4	5·4	0·5	5·7	1·3	44·3	9·4	52·9	1: 10	Sheep
Dichrostachys glomerata pods and seeds	1	90	10·8	1·4	55·8	26·6	5·4	0·4	4·0	1·0	37·5	14·7	49·4	1: 14	Sheep
Adansonia digitata (Basbab) fruit pulp and seeds	1	89	11·2	7·8	50·0	26·4	4·6	0·1	5·4	6·9	31·0	9·1	44·6	1: 10	Sheep
12. Cereals															
Buckwheat, ground	1	87	12·1	2·0	68·3	14·8	2·8	N.D.	8·3	1·2	48·0	9·9	63·4	1: 7	Sheep
Bulrush millet, whole	1	87	14·1	4·5	76·4	3·1	1·9	N.D.	7·0	3·2	49·3	1·2	60·7	1: 8	Sheep
Maize, crushed	1	88	11·0	4·3	78·9	3·6	2·2	N.D.	7·0	3·5	71·9	1·8	87·8	1: 12	Sheep
Maize, crushed	2	88	8·9	2·8	82·6	3·2	2·5	N.D.	6·8	1·3	72·6	2·2	83·6	1: 11	Oxen
White millet, whole	1	87	12·0	3·3	78·9	3·3	2·5	0·6	8·3	2·7	77·1	1·3	87·4	1: 10	Sheep
13. Legume Seeds															
Cowpeas	3	86	26·9	1·4	61·6	6·5	3·6	0·3	21·6	0·9	58·1	4·0	81·7	1: 3	Sheep
Maharage beans	1	88	23·1	1·4	66·6	4·8	4·1	0·2	15·4	0·5	58·5	2·4	74·1	1: 4	Sheep
Velvet Beans	1	88	24·9	4·4	58·6	9·2	2·9	0·1	20·1	2·8	57·0	6·6	85·8	1: 3	Sheep
14. Oil Seeds															
Cottonseed	1	89	22·5	18·7	26·0	27·8	5·0	0·6	17·8	17·4	16·3	9·2	79·0	1: 4	Sheep
Cottonseed	2	89	20·3	15·2	32·1	27·0	5·4	0·8	13·2	13·6	16·8	15·6	72·9	1: 5	Oxen
15. Cereal By-products															
Maize bran	1	86	8·8	10·1	68·0	7·0	6·1	3·2	5·6	8·3	49·4	0·1	68·5	1: 12	Sheep
Millet bran (White variety)	1	88	13·8	6·0	65·3	6·2	8·7	4·3	10·0	4·9	57·4	3·4	76·4	1: 8	Sheep
Millet bran (Red variety)	1	88	13·0	7·0	66·6	6·3	7·1	3·0	—	—	—	—	—	—	—
Residues from production of native beer	1	25	23·8	7·3	55·1	8·7	5·1	3·2	—	—	—	—	—	—	—
Rice glumes	1	90	3·8	3·2	38·8	43·7	10·5	9·5	0·7	1·6	16·2	11·5	6·0	1: 47	Sheep
Rice bran	1	88	13·3	10·1	45·7	18·3	12·6	8·7	10·8	8·8	30·2	5·7	58·2	1: 5	Sheep
Rice polishings (First run)	1	87	17·0	15·3	55·1	5·9	6·7	0·6	14·2	13·1	40·9	2·3	80·0	1: 5	Sheep
Rice polishings (Second run)	1	87	15·6	17·7	54·0	6·1	6·6	0·6	12·1	15·1	43·4	2·2	84·6	1: 6	Sheep
Wheat bran	2	88	14·9	3·7	65·1	12·3	4·0	0·1	10·3	2·1	45·3	2·5	49·8	1: 4	Oxen
Wheat bran	1	88	14·3	4·0	64·9	12·7	4·1	0·0	10·1	1·8	42·8	6·2	49·2	1: 4	Sheep
16. Oil Mill Residues															
Coco-nut cake	1	89	21·7	15·0	39·2	15·2	8·9	3·2	15·9	14·8	34·7	7·0	89·8	1: 4	Sheep
Groundnut cake (Machine milled)	1	88	46·2	4·7	36·8	5·6	6·7	2·2	43·3	4·4	36·6	5·1	91·9	1: 1	Sheep
Groundnut cake (Machine milled)	1	88	43·3	6·9	38·0	5·9	5·9	1·7	40·7	6·7	30·0	3·3	85·8	1: 1	Oxen
Groundnut cake (Brade punitive mill)	1	88	53·2	8·9	27·8	4·8	5·3	0·7	48·4	7·4	26·8	3·8	92·0	1: 8	Sheep
Kapok seed cake	1	88	25·8	5·6	37·9	21·8	8·9	1·6	10·6	2·9	27·1	2·3	40·0	1: 3	Oxen
Sesame cake	1	88	43·2	11·6	27·1	6·5	11·6	2·9	37·8	10·4	19·8	1·3	79·2	1: 1	Sheep
17. Pumpkins															
Pumpkins, var. *Selonse*	1	11	20·6	5·4	54·9	10·4	8·7	0·7	18·0	4·7	54·2	9·6	85·3	1: 4	Sheep
Pumpkins, var. *Boer*	1	8	20·9	9·2	41·5	17·8	10·6	0·6	17·0	8·5	36·0	15·2	73·1	1: 4	Sheep
Pumpkins, var. *Laubsher*	1	14	18·3	10·1	37·7	26·4	7·5	0·4	15·3	10·0	31·5	18·2	67·9	1: 4	Sheep
Pumpkins, var. *Culwick*	1	19	17·8	10·1	43·2	18·1	10·8	0·6	15·8	8·9	41·4	12·2	74·9	1: 4	Sheep
Pumpkins, var. *Mamusa*	1	18	20·5	8·0	45·6	18·6	7·3	0·2	16·2	6·9	32·2	8·9	58·6	1: 3	Sheep
Pumpkins, var. *Majenge*	1	13	24·0	7·9	38·6	19·5	10·0	0·1	18·3	6·2	27·0	10·8	55·5	1: 3	Sheep
Water melon, var. *Mahikwi*	1	7	10·1	6·7	54·5	21·9	6·8	0·3	6·3	6·2	37·5	13·1	54·7	1: 10	Sheep

THE COMPOSITION AND NUTRITIVE VALUE OF TANGANYIKA FEEDING STUFFS

II.—FIGURES FOR SWINE

	Number of trials	Normal dry matter	Dry Matter Composition						Digestible Nutrients				Starch equivalent	Nutritive ratio
			Crude protein	Ether extract	N-free extract	Crude fibre	Total ash	Silica (SiO_2)	Crude protein	Ether extract	N-free extract	Crude fibre		
1. Cereal Grains														
Barley, ground	1	86	12·5	1·7	77·2	6·9	1·7	0·0	9·3	0·6	72·0	1·4	80·8	1:8
Buckwheat, ground ..	1	87	12·1	3·6	67·8	14·4	2·1	0·6	8·8	0·9	57·8	8·7	71·2	1:8
Bulrush millet, whole ..	1	87	14·1	4·5	76·4	3·1	1·9	0·0	8·5	2·9	47·4	1·1	59·5	1:6
Maize, ground	1	88	12·3	3·9	79·7	2·5	1·6	0·0	11·0	2·4	74·8	0·9	91·1	1:7
Wheat, ground	1	88	16·8	2·3	67·6	10·8	2·5	0·0	15·8	2·3	63·1	8·2	83·6	1:5
White millet, whole ..	1	87	12·0	3·4	77·7	4·8	2·1	0·3	7·6	2·0	50·2	3·4	61·6	1:8
2. Cereal By-products														
Rice polishings, first run	1	87	16·5	15·5	55·5	5·7	6·8	0·3	14·3	14·4	46·8	2·0	88·0	1:6
Rice polishings, second run	1	87	13·3	14·5	56·0	5·6	10·6	1·4	11·4	13·2	52·2	3·1	89·4	1:7
Wheat bran, straight run	1	88	16·9	2·0	65·1	10·9	5·1	0·0	12·2	0·8	44·3	0·8	44·8	1:4
3. Legume Seeds														
Cowpeas (ground) ..	1	86	28·9	2·0	57·2	7·6	4·3	0·0	27·1	0·8	51·5	3·7	79·8	1:2
Field peas	1	87	24·5	1·1	61·9	9·4	3·1	0·0	21·8	0·1	55·7	5·1	79·7	1:3
Pigeon peas	1	87	22·9	2·9	61·7	8·3	4·2	0·0	21·0	1·0	53·2	7·1	80·6	1:3
4. Oil Seeds														
Cottonseed	1	89	21·4	15·8	32·0	25·9	4·9	0·2	10·4	6·7	8·1	9·2	40·9	1:3
5. Protein Supplements														
Groundnut cake (crushed)	1	89	52·4	9·0	26·6	6·0	6·0	N.D.	49·1	7·5	22·5	4·2	89·1	1:1
Meat meal	1	88	73·2	19·7	–	–	7·1	N.D.	66·2	18·8	–	–	107·4	1:1
*Separated milk	1	10	3·4	0·2	4·6	–	0·7	0·0	3·4	0·2	4·6	–	8·1	1:1

*Figures per 100 parts of liquid separated Milk.

(*Received for publication on 28th October*, 1942)

THE CONSERVATION OF ACTIVITY IN PAPAIN

The precise nature of the enzymic activities of papain has been the subject of considerable uncertainty and disagreement. The differences in the properties of freshly-tapped latex obtained from fruits at different stages of development, variations in activity of preparations made by different methods from the latex, deterioration in activity on keeping, the action of "activators", notably hydrogen cyanide, in increasing or restoring activity, and the presence of natural activators and inhibitors in the latex, have all been the subjects of contributions to technical journals.

Reference may be made in particular to a communication made to *Nature* (1937, 139, 249) by M. Frankel, R. Maimin and B. Shapiro, of the Hebrew University, Jerusalem, and to various papers by A. K. Balls, of the United States Department of Agriculture, and his collaborators (*J. Biol. Chem.*, 1937, 121, 737; *ibid.*, 130, 699; *Ind Eng Chem.*, 1940, 32, 1144; *ibid.*, 1940, 32, 1277).

Pending clarification of these various problems, a practical interest attaches to United States Patent No. 2,257,218, September 30, 1941, granted to A. K. Balls, H. Lineweaver and S. Schwimmer, assignors to the Secretary of Agriculture of the United States, entitled "Process for the Preparation of Papain". It is claimed by the patentees that whereas papain as ordinarily prepared by drying the latex of the green fruit is less potent per unit of dry weight than the latex from which it is prepared, and deteriorates on storage even for periods as short as a few weeks, the new process results in a product which retains nearly all the original activity of the latex and may be stored for many months without apparent deterioration. It is stated that the natural activator of the proteolytic enzymes, which occurs in the latex in considerable quantity, remains in the finished papain.

The process consists simply in adding common salt to the latex, either before or after it has clotted, mixing thoroughly, and then partially drying the mixture, preferably in a vacuum and at a temperature not exceeding 55°C. The quantity of salt used may vary within wide limits, but with latex of average water content may be about one-tenth of the weight of the fresh latex. The evaporated product, consisting of a greyish white thick paste, should be kept in airtight containers.

"TAKE ALL" DISEASE OF CEREALS
(OPHIOBOLUS GRAMINIS)

By R. M. Nattrass, B.Sc. Agric. (Lond.), Ph.D. (Lond.), D.I.C.,
Senior Plant Pathologist, Kenya

The "Take all" or "Whiteheads" disease of wheat has now been known in Kenya for many years and has on occasion caused considerable loss. It is not unlikely that there will be a tendency for the disease to increase in intensity and distribution as a result of the drive for increased production of wheat which may lead to this crop being grown with greater frequency on the same land.

Although the attention of Kenya farmers has been drawn to this disease in the past, a reminder of the symptoms and a review of some of the more recent work[1] on the fungus may not be out of place.

Two types of symptoms typically occur in the field. The "foot rot" or "take all", when the plants are attacked in the early stages of growth and may even be killed when 6 to 8 inches high. Plants may, however, be similarly affected at any stage of growth up to the emergence of the ear. This form of the disease frequently occurs in definite patches, but may also be dispersed throughout the field, in which case it often passes unnoticed.

The second form, known as the "whiteheads" stage of the disease, appears after the emergence of the ear. It is characterized by a bleaching of the plant and of the ear, which fails to fill out and yields either withered or no grain. Affected plants come away easily in the hand owing to partial destruction of the root system. This form is usually scattered throughout the crop.

The effect on the plant of the disease also varies somewhat according to the weather about heading time. As much of the root system is out of action, hot dry weather will intensify the symptoms, while cool, showery weather will enable the plant to withstand, to some extent, the onslaught of the disease.

Both the "take all" and "whiteheads" forms of the disease are caused by the same fungus, *Ophiobolus graminis*. There may be no sharply dividing line between the two forms. The occurrence of either is largely dependent on the stage of development of the plant when infection takes place and, according to some authorities, on the amount and distribution of the fungus in the soil at the time of planting. The distinct patches are thought to occur where there is a heavy concentration of mycelium in the soil and the more scattered, "whiteheads", form where the concentration is lower. The same thing might occur were the fungus to be evenly distributed and certain patches of soil to be more suited to the development of the fungus.

In addition to the general characters of affected plants as seen in the field, the disease can be recognized by the blackened base of the stems and by a dark weft or network of mycelium which is disclosed when the lower leaf sheath is peeled off. The roots themselves are short and have a characteristic woolly appearance due to a dense mat of root hairs from which the adhering soil can be removed only with difficulty.

A perfect or resting stage of the fungus which produces wind dispersed spores also occurs, especially in wet seasons, as minute spherical black bodies at the base of the stems.

During wet weather the empty ears may be blackened by the fungus *Cladosporium herbarum* and species of *Alternaria*. These, however, have nothing to do with the "whiteheads" disease and may similarly occur on ears which are barren from other causes. *Ophiobolus graminis* occurs only at the base of the plant, never higher up; so that the fungus is never carried by the seed.

Recent work on the life history of the fungus has shown that it belongs to the class of soil fungi described as soil invaders as distinct from soil inhabitants. That is to say, the fungus does not normally live in the soil on dead organic matter, as can a number of parasitic fungi, but is dependent for its existence on the presence of the host plant in the soil, where it persists on infected root and stubble. Here, as long as it survives, it is a danger to any subsequent wheat crop.

During the growth of a susceptible crop, the fungus, if soil conditions are favourable, grows along the roots and spreads from plant to

[1] Summarized by S. D. Garret. The Take All Disease of Cereals. *Imp. Bur. Soil Science Tech. Communication* No. 41. 1942.

plant by root contact. The spread of the actively growing fungus is favoured in light-textured, well-aerated soils with an alkaline reaction. The growth is slower on heavy, well-compacted acid soils. It has been found in Australia, for instance, that the opening up of virgin land by too deep cultivation, or by the ploughing in of long straw, thus increasing aeration, tends to encourage "take all". Newly opened-up country sometimes suffers severely from this disease, but less after twenty years or so of cultivation. This is considered to be due to the gradual building up of organic reserves, consequent increase in the population of micro-organisms, and alteration of soil texture.

There are two phases in the vegetative life of the fungus, one a parasitic phase when the fungus is active on the roots of the growing crop, and a second phase when the fungus is still alive but more or less quiescent on the stubble and roots of the infected crop. As has already been stated above, the fungus cannot flourish on soil organic matter, so that the question as to whether subsequent crops will be attacked is dependent on how long the fungus will survive on the previous crop debris. This, of course, has an important bearing on control measures. Thus, if no susceptible crops were grown for a sufficiently long period, the fungus would eventually disappear. It is now known, however, that other organisms in the soil play an important part in determining how long the "take all" mycelium will persist on the crop remains.

It has been shown that, in general, soil conditions which favour microbiological activity in the soil also favour the rapid disappearance of the "take all" mycelium. Until comparatively recently it was thought that this was due to the "resting" mycelium of the fungus being itself attacked and destroyed by the micro-organisms, but more recent work has shown that the action of these organisms is competitive rather than antagonistic and that by their activity available nitrogen in the roots and straw is more quickly consumed, thus depriving the "take all" fungus of available food material.

Experimentally, destruction of the mycelium has been hastened by dressings of material poor in nitrogen and has been retarded by addition of organic nitrogen. From the point of view of the farmer it can be said that soil conditions favouring the general activity of soil micro-organisms favour the development of the fungus in the active stage and hasten its disappearance in the soil during the quiescent stage. Thus green manuring, which stimulates general microbial activity, encourages the disappearance of the mycelium on the crop remains.

How long the fungus will persist in the soil after an infected crop depends largely on the nature of the soil. The survival of the fungus may also be assisted by the growth of wild grasses, of which a number are known to act as hosts.

It is known that in Kenya, as well as elsewhere, resting spores of the fungus are produced on infected stubble and that these spores are ejected into the air and may be carried on to clean land. It was at one time thought that these spores played an important part in disseminating the disease and that they were responsible, in part, for the sporadic occurrence of the "whiteheads" form and the appearance of the disease on land hitherto free. Recent work has shown that, in England at any rate, infection from these spores occurs only exceptionally. It is now generally accepted that the infection comes from the soil and it is to the soil therefore that all control measures must be directed.

As the fungus can only survive on the remains of an infected crop or on susceptible grass, the longer the interval between two crops the more likelihood is there of the fungus being eliminated. Barley is only slightly less susceptible than wheat. Rye is comparatively resistant, while oats are almost immune to the variety of the fungus which attacks wheat and barley. There is, however, in Wales and other parts of the British Isles, where oats are extensively grown, a special form or distinct variety of the fungus which does attack oats. As this form is unlikely to be present in Kenya, oats can safely be grown after an infected wheat or barley crop. Maize is not apparently attacked and may safely be alternated with wheat where the altitude permits. Darnel (*Lolium temulentum*), which occurs on cultivated land in Kenya, is attacked by and can harbour the fungus.

As long an interval as possible should be left between two susceptible crops, although the disease can be kept under control through comparatively short crop rotations. Satisfactory control can usually be obtained by alternating wheat with oats, any non-cereal crop or a bare fallow. As the fungus may persist on a number of grasses, the land must be kept clean during the interval. It is possible that under

certain conditions it may be safe to take two wheat crops running on heavy soils when only a few whiteheads are present if ploughing is done early. Burning the stubble or straw after harvest destroys most of the infective material above ground. If long straw is ploughed under it may open up the soil to such an extent as to favour the development of the disease in the next crop.

During the growth of the crop the active stage of the fungus on the roots develops most rapidly in loose open soils, especially those of an alkaline character. The spread of the fungus can therefore be checked by compacting the soil as much as possible and avoiding the use of lime or alkaline fertilizers. The preparation of the seed bed should be started as early as possible and drilling delayed so that maximum consolidation can be effected. This fact has been demonstrated by many years' experience in Australia, where cultural operations are directed to a well-compacted seed bed. Here the depth of cultivation is reduced to two to three inches on the very light soils, the compacted layers beneath being undisturbed. Sheep on the lighter soils are especially valuable in this connexion. Similarly the opening up of the soil by working the dry land or by the incorporation of straw or fresh farmyard manure is to be avoided and fertilizers with an acid reaction such as sulphate of ammonia and superphosphate preferred.

Keeping the soil in good heart may not check the fungus but it certainly assists the plants to resist its onslaughts. Plants suffer more severely when the general fertility is low. Under favourable conditions the wheat plant can put out fresh roots as the earlier ones are destroyed and so in some measure "grow away" from the fungus.

The control measures may be summarized as follows:—

(1) The disease is more likely to be troublesome on light than on heavy land.

(2) A firm seed bed is essential; the ploughing under of long straw or other resistant plant residues is to be avoided.

(3) If the disease is known to be present two wheat crops should not be taken in succession. It is especially dangerous to do so on light soils.

(4) Keep down the grass weeds on fallows and among other crops; these harbour the fungus.

(5) Keep up, as far as possible, the organic matter content of the soil and apply superphosphate with the wheat crop.

(*Received for publication on 16th November*, 1942)

THE SCIENTIST'S RESPONSIBILITY

The fundamental problem confronting science in the ethical sphere is that of making itself known to mankind as a whole. What fraction of the population of any civilized country—even our own—can be credited with a proper conception of science, its aims, its methods, its results? On the most generous estimate it must be very small. Ignorance of science is by no means confined to the humbler ranks of society. It pervades every walk of life, from the lowest to the highest. It is particularly reflected in the popular press. Each day the newspapers contain elementary errors, misleading references, or out-of-date statements concerning scientific progress and discovery. It is not all their fault. There is nowhere among men of science a general disposition—or indeed ability—to see that the current thought and practice of laboratory and lecture hall are made available to the public through the press, the cinematograph, and other media. There is frequently, it must be confessed, a tendency to avoid contact with the newspaper reporter instead of teaching him to be an accurate and intelligent translator. It is therefore not surprising that the scientific attitude of mind is misunderstood, and even mistrusted, by the public. How slender is the footing which science has won in the public mind can be inferred from the smouldering fires of astrological superstition, now being fanned into flame by the winds of war. How little even educated Englishman knows of the achievements of British scientists, either past or contemporary, is shown in his proneness to assume that chemical genius and organization are German monopolies.

The remedy lies in the hands of scientists themselves; and in no country have they a more insistent duty than in Great Britain, for there is no other country with heavier political responsibility overseas, and none whose national characteristic is more typically reticence and under-statement. Science, indeed, must become articulate. Even though publicity may be repellent to scientists, they must, as a body, vie with the politicians, for science holds the keys of the future.

Endeavour, Vol. 1, p. 89, July, 1942.

FOOD CROPS AS INDICATOR PLANTS IN UGANDA

By A. S. Thomas, B.Sc. (Hort.), M.Sc., A.I.C.T.A., Economic Botanist,
Department of Agriculture, Uganda

The banana is the most important food crop throughout the wetter parts of Uganda. In some places it covers the whole countryside; parts of the western slopes of Mount Elgon are clothed with a pale green mantle of banana gardens and only small patches of land, usually on rocky knolls and in the bottom of the river valleys, are unplanted with the crop.

In other parts of the country, however, the banana gardens are confined to well-defined belts; on the hills near Mount Ruwenzori also there are stretches of banana gardens miles in length; in some localities in the Masaka district, the banana gardens cover the tops of the hills, yet there are few on the slopes or in the valleys. This same pattern of vegetation was typical of the Sese Islands years ago when they were densely populated—banana gardens and other food crops were dense on the hill-tops, but the sides of the hills were under a cover of short grass. In other districts the banana gardens are near the base of the hills; for example, in the parts of Ankole and Toro the hills are covered with short grassland and the banana gardens are either in the folds of the hills or else at the bottom of the steeper slopes, but above the swamps in the valleys.

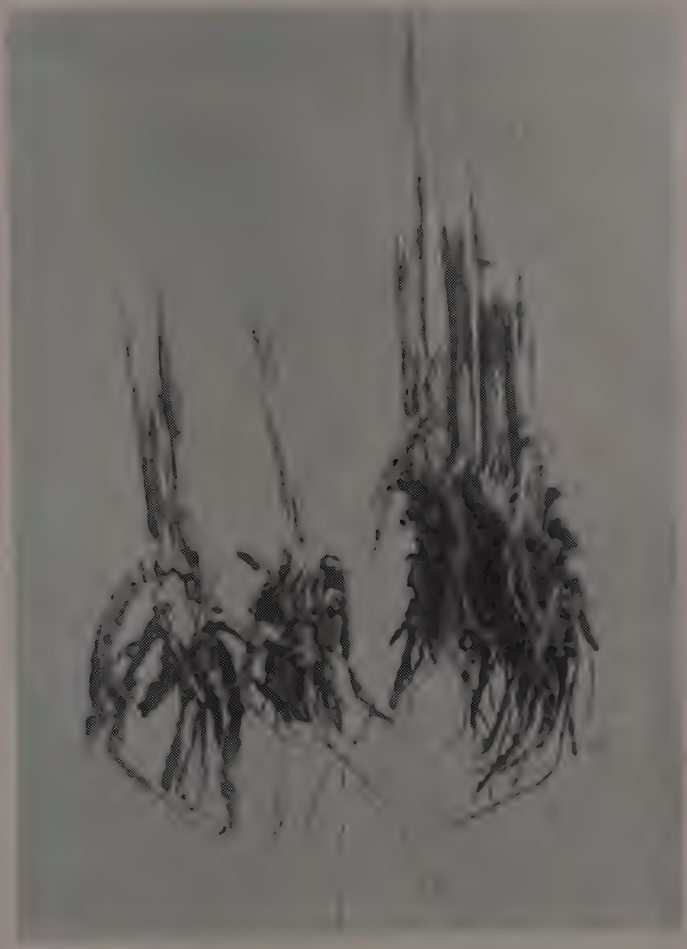
In the densely populated parts of Buganda around Kampala there are many banana gardens, but they do not form a distinct pattern, being scattered over the landscape, on slopes and on level ground; they are absent from the stony tops of the higher hills and from the swampy land in the bottom of the valleys, situations where the elephant grass (*Pennisetum purpureum*) that is typical of this region is replaced by other grasses, such as *Cymbopogon afronardus*, which are typical of poorer soils (Thomas, 1940).

Just as elephant grass is an indicator plant of the better soils, so also is the banana; that is the reason of the different patterns that the banana gardens form in the landscape. Mount Elgon is an extinct volcano and, as the soils on its slopes are some of the most fertile in Uganda, it is possible to grow the banana in such large stretches. In other districts the soils are not so rich and it is only in restricted areas that they are good enough to support banana gardens for any length of time. The land on the hills near Mount Ruwenzori is richer than that on the actual slopes of the mountain or that at some distance from the mountain. In the Masaka district the good land is often restricted to the tops of low hills, and that is the reason why the banana gardens are confined to such positions. In the Ankole district the most fertile soils are often near the base of the hills, for most of the nutrients have been leached down from the slopes above.

Near Kampala bananas are never planted on land that is not good enough for elephant grass, for the peasants know well that the crop will be a complete failure on such land; not all elephant grassland is good enough for bananas—the grass will grow on soils which are fairly rich but shallow or gravelly, yet the deep-rooted bananas need ample soil. Soils which are too poor for bananas are known in Luganda as "lunyu" and many plants are known to be indicators of such soils—ferns, the grass *Cymbopogon afronardus, Acanthus arboreus* and several members of the *Melastomaceae*, a family of plants which throughout Uganda is usually associated with acid, poor soils. Where the banana gardens are confined to small compact areas, as in Ankole, it may be assumed that the soils are poor—a striking example of this condition is to be seen in Bukoba; where the banana gardens are widely scattered over the countryside, there it may be safely assumed that the land is fairly rich; where the whole of the land is covered with banana gardens, as in Bugishu on the slopes of Mount Elgon, it is obvious that the land is very fertile, as it will support a crop of bananas indefinitely, without the necessity of regeneration under a ley of elephant grass.

Not only does the distribution of the banana gardens furnish a useful guide to the quality of the soil, but so does the vigour of the individual clumps; the height of the bananas in Bugishu can be matched in few parts of Uganda. Careful cultivation and control of the Banana Weevil (*Cosmopolites sordidus*) are necessary if the bananas are to reach their full size; but, if the soil is unsuitable, no amount of cultivation will make the banana flourish. Manuring will lead to the regeneration of a worn-out banana garden and kraal manure is used to this purpose in some parts of East Africa, for example on the slopes of Kilimanjaro and in Bukoba. Kraal manure has been little used around Kampala, although the

"TAKE ALL" DISEASE OF CEREALS—WHEAT



Showing the blackened base of the stems and partially destroyed root system.

[*To face page* 136

The Bugishu district in the east of Uganda. Good soil on the lower slopes of Mount Elgon, covered with banana gardens. Altitude about 5,000 feet; annual rainfall 50 to 55 inches, well distributed.

The Toro district in the west of Uganda. Poor soil in hilly country. The hills are covered with grassland in which *Cymbopogon afronardus* is dominant; there are patches of bananas at the base of the hills. In the foreground women are clearing and burning grass before sowing *Eleusine*. The altitude and the annual rainfall are almost identical with those of the area illustrated above.

peasants realize the necessity of adding fertilizer to the soil; instead of applying the manure from their cattle, they encourage strangers, such as the Banyaruanda porters who come to seek work in Uganda, to live in poor banana gardens in order that, by the accumulation of ashes and household refuse, the fertility of the soil may be restored.

It is by the accumulation of nutrients around the homesteads that the pattern of poor soils and good soils has been built up in many parts of Uganda. If the ordinary climatic soil-forming agencies only were at work, it would be expected that nutrients would accumulate near the base of the hills, as in Ankole; it would be hard to explain why the fertile land should be confined to the tops of the hills, except in places like the Sese Islands, where there are lateritic ironstone pavements which prevent undue leaching of the soils. The explanation of the fertile hill-tops lies in the habits of the people, who tend there to build their houses, rather than in the mosquito-ridden valleys; where the houses are, there also are the cattle kraals and, by the accumulation of manure, as well as by the accumulation of ashes and refuse, the land becomes much richer than the average for the district as a whole.

It seems that there must be about fifty distinct varieties of bananas in cultivation in Uganda at the present time; between thirty and forty of them were grown here before the advent of the Europeans at the end of the last century. No instance is known of the formation of seed by any of these cultivated bananas in Uganda, so that it is unlikely that any of these forms are derived from locally raised seedlings; but there is evidence that some bud mutations have occurred and still occur in this country. Nevertheless, it is certain that a great number of forms must have been introduced, and it is interesting to speculate on the route by which they were brought from south-east Asia, where all bananas of this group appear to have originated. It seems unlikely that the bananas came into Uganda from the north, on account of the great area of the sudd and swamp which obstructs the Nile valley; or from the east, for banana suckers would be heavy material to carry across the cold dry uplands of Kenya; or from the west, for there was little cultivation in the dense forest of the Congo basin. The southern route, via Lake Tanganyika, Lake Nyasa and the Zambezi valley to the sea coast, seems most probable, for it passes through country which is suitable for banana cultivation. The question then remains as to how the bananas reached the coast of Africa; were they brought by the Arabs, by the Portuguese or by the Chinese, who seem to have carried out considerable trade with Africa some hundreds of years ago?

Some of the varieties recently introduced are much more vigorous than the bananas which have been grown for a long time in the Protectorate; none of the older types are so tall as the yellow and red varieties used for dessert in Uganda at the present time. As a rule, the true bananas (*Musa sapientium*) grown in Uganda, whose fruit may be eaten raw, will flourish on poorer soils than are suited to the plantains (*Musa paradisiaca*), whose fruit must be cooked before eating. One group of varieties, known as "Gonja", which are intermediate in character between bananas and plantains and which are used both for eating and for beer-making, will grow well on soils not good enough for other types. Therefore, in some areas of relatively poor soils, for example on the Sese Islands, the types grown are almost exclusively of this group, which are used mostly for beer-making; the banana is often referred to as the food of the Baganda, but in many areas it may more correctly be termed their drink.

Finger Mallet (*Eleusine coracana*), known locally as "Bulo" or "Wimbi", is the most important food crop in the drier areas of Uganda. In Uganda, as in Nyasaland (Wilson, 1941), the methods of cultivation differ greatly according to the soil, and it is the differences in these methods which may be used as indicators of the quality of land. Wilson pointed out that on poor land, which could not be used for the cultivation of maize, the tribes of the Mzimba district were in the habit of carrying on trees and brushwood and burning them so that the soil might become good enough to carry one or two crops of finger millet; on better land, good enough to support one or two crops of maize, such an intensive burning was not necessary.

Comparable differences in practice may be seen in Uganda: in districts where the soils are good, *Eleusine coracana* may be sown without much previous burning or cultivation, for the crop prefers a firm seed bed; but in areas where the soils are poor, as for example in parts of the Toro district which are under a cover of *Cymbopogon afronardus*, the tufts of grass are hoed up, piled in heaps and burnt to provide ashes for spreading on the ground

before sowing the millet (photo 2). These Toro soils are deep, but are acid in reaction and poorly supplied with bases; striking proof of their poverty has been afforded by experience of cultivating tea on them; for, although tea prefers an acid soil, yet heavy manuring has been required in order that the tea might make growth comparable with that made on better land, which had been under a cover of elephant grass, in the same neighbourhood.

The original home of *Eleusine coracana* is not definitely known, but it is probable that it originated in Northern Africa, in a fairly dry area where the soil would tend to be better supplied with bases than would land near the equator where, on account of the heavier and more evenly distributed rainfall, the bases tend to be leached out. Finger millet seems to be one of the oldest food crops of tropical Africa, a hypothesis supported by the degree to which the plant is connected with the religious beliefs of tribes in many parts of the continent; an interesting example of these beliefs is afforded by the Krobo tribe, who now live in the forest areas of the Gold Coast, cultivating yams, maize, plantains and *Colocasia* as their main food crops, but who still plant very small patches of *Eleusine* to be used in religious practices because it was their staple food before they migrated from drier areas to the east some hundreds of years ago.

Finger millet is the staple food crop of tribes now living in areas whose soils are generally acid, like those dominated by *Brachystegia* in the southern parts of tropical Africa. The practice of burning the vegetation before cultivation of crops on such land has often been condemned, without consideration of the fact that such burning is essential if good harvests of *Eleusine* are to be reaped. If the practice of burning is to be stopped, some alternative food crop must be cultivated; the provision of food is usually the concern of the women of African tribes and, as with other races, they are the most conservative members of the community. The methods employed in the cultivation of African food crops may seem strange to Europeans, but they are determined by the weight of tribal tradition, which is based on a system of trial and error extending over a long period of years. For example, *Eleusine coracana* is almost always sown in a mixture of varieties in Uganda, for these varieties differ greatly in their reaction to weather conditions—one will yield best one year and another will yield best in the next; so that more even yields are to be obtained by sowing a number of varieties in admixture.

Sorghum (*Sorghum vulgare*), the other major grain crop which appears to be indigenous to Africa, also requires fairly good soil, although it does not demand so high a fertility as maize. The great value of sorghum lies in its drought-resisting qualities and as a rule in Uganda, the sparser and more irregular the rainfall of a district, the more important does sorghum rank in the economy of the inhabitants. Bulrush Millet (*Pennisetum typhoides*), another drought-resistant cereal which probably is native to Africa, is also locally important in the drier areas of Uganda, for it will yield well on soils which are too poor for sorghum and, as it has a short growing season, it will ripen a crop on a very small rainfall. Maize (*Zea mays*), an American plant, is not a major food crop in Uganda, although small amounts of it are grown in many districts—in both wet areas and dry areas, at low altitudes and at high altitudes. The crop demands rich soil and therefore it is often planted in small patches near homesteads, or in rows beside paths, situations where there is usually an accumulation of plant nutrients in the soil.

Finger millet, sorghum, bulrush millet and maize are all liable to attack by witch weeds, *Striga* spp., of which *S. hermonthica* is the most common in Uganda. There is evidence that, just as some semi-parasitic members of the same family, the *Scrophulariaceae*, are indicators of poor soil in temperate regions, so also in Uganda the local *Striga* spp. may be indicative of low soil-fertility; for witch weed is often most abundant on land whose fertility has been depleted by successive crops of cereals and it has been stated that some measure of control is achieved by heavily manuring the soil.

Some of the root crops are more suited to poor soils than are the grain crops. Sweet potatoes (*Ipomoea batatas*), which came from tropical America, have long been grown in Uganda and are largely planted in the wetter parts on soils which are too poor to support bananas. Large quantities are grown on the eroded, exhausted land around Kampala and in the Sese Islands where, as mentioned above, the general standard of fertility is low, sweet potatoes constitute the most important food crop.

Cassava (*Manihot utilissima*), which also originated in America, is a comparatively new introduction to Uganda; Emin Pasha (1888) reported that "Manioc (*Manihot utilissima*) is found only in the south and has been intro-

duced from the other side of the equator". This crop also, like sweet potatoes, is valuable in that it will give good yields on relatively poor soils and for that reason is planted at the end of rotations; it is not greatly relished in Uganda, but it forms an excellent reserve against famine conditions.

Coleus dysentericus and *Coleus dazo* are root crop indigenous to Africa which can be grown on poor soils; neither of them gives large yields and neither of them is very palatable and they are of small importance in Uganda at the present time. The Bambara groundnut (*Voandzeia subterranea*) is also native to tropical Africa and can be grown on poor soils; but it is now planted on a very small scale in comparison with the ordinary groundnut (*Arachis hypogaea*), which appears to have come from South America.

It is surprising that, from so large a land mass as Africa, so few important tropical food crops should have been derived. Sorghum, finger millet, pigeon pea (*Cajanus cajan*) and cowpea (*Vigna unguiculata*) all seem to be indigenous to Africa (Sampson, 1936); certain yams (*Dioscorea* spp.) are collected in the wild state for food, as in the north of Uganda, and some of the indigenous species are cultivated on a small scale, especially in West Africa; but none of them are of such general importance as *Dioscorea alata* and *Dioscorea esculenta*, which have come from tropical Asia. Among vegetables, the cosmopolitan *Amaranthus* spp. may be indigenous; there are several wild edible species of *Solanum*, of which one—the brinjal, *Solanum melongena*—is much grown in other tropical regions, but even this species is not of such general importance as the tomato (*Lycopersicum esculentum*), a member of a closely allied genus derived from America. None of the spice plants native to Africa are of much consequence in comparison with the asiatic spices or with the *Capsicum* spp., which came from America. Coffee (*Coffea arabica* and *C. canephora*) is the one crop of major importance in world trade which has originated in tropical Africa.

With the exception of finger millet and sorghum, none of the starchy food crops now important in Africa are indigenous to the continent; it has been fortunate for the inhabitants of Africa that exotic crops have proved themselves so well suited to the range of conditions here; bananas on good soils; sweet potato and cassava on poorer soils; *Colocasia antiquorum* in wet situations; the ordinary potato (*Solanum tuberosum*) and maize in the highlands. In the case of the pulse crops also, it is the exotic types which make up the bulk of the foodstuffs; the pigeon pea and the cowpea, which probably originated in Africa, are very widely grown, but they are not such important crops as the groundnut in drier areas, especially in places where the soils are sandy, and the many varieties of *Phaseolus lunatus* (which originated in America) in the wetter areas.

The introduction of all these crops has exercised a profound influence on the diet and on the habits of African peoples: without them it would be impossible for so dense a population to exist in many parts of the continent. This density of settlement and the cultivation of exotic food crops has produced far-reaching changes in many areas of Uganda; the climax vegetation has disappeared and plants of secondary growth, especially the grasses, must be used as indicator plants (Thomas, 1940). Much information about soils and climates also may be gained by study of the kinds of food crops which are grown and the methods of cultivation that are employed.

The population of Uganda and of many other parts of tropical Africa is now on the increase; what changes must that increase entail in the diet of the people? And what changes in the methods of cultivation will be entailed? There is still space in most of Uganda, and in many other parts of East Africa, for a modified form of shifting cultivation to be practised whereby after a period under cultivation land is allowed to rest under grass or bush fallow in order that it may regain its fertility and that the crumb structure of the soil may be restored.

In the more densely populated countries of tropical Asia, pressure on the land is so great that long-term fallows are not possible; it is essential that all the land should be utilized to grow food. Trees have become scarce in many areas and bamboos, which provide a large number of light poles from a small space, are utilized for building material. The eastern countries have been driven to adopt systems of agriculture more intensive and more laborious than the practice of shifting cultivation. Terracing and irrigation make the best possible use of the land and of water; Lord Hailey (1938) has pointed out that "The most ancient, universal and effective way of increasing absorption is the use of terraces". Terracing has been used in the past in several parts of Africa—in the Cameroons (Stanhope White, 1941), in Tanganyika, and even in Uganda. Irrigation also has long been used by

the Acholi on the slopes of the Imatong Mountains in the north of Uganda, but it is not nearly so important a part of their agricultural system as in the case of the Wachagga on Mount Kilimanjaro.

Agriculture in tropical Asia centres round the cultivation of transplanted swamp rice, the most important food crop in the world, which has attained that position because it will produce a greater amount of food per acre than any other. At least two wild species of *Oryza* occur in Uganda, but there seems to have been no attempt to domesticate these species here or in any other part of tropical East Africa; the little rice that is grown is of Indian origin. With an increasing pressure on land, it is probable that, at some time in the future, Uganda will have to develop and utilize for rice growing the numerous swampy valleys of the country, instead of concentrating the agriculture on the hills.

REFERENCES

Emin Pasha (1888).—*Emin Pasha in Central Africa*, p. 80.

Hailey, Lord (1938).—*An African Survey*, p. 1064.

Sampson, H. C. (1936).—Cultivated Crop Plants of the British Empire and Anglo-Egyptian Sudan (Tropical and Sub-tropical). *Kew Bull. Additional Series* 12.

Stanhope White (1941).—The Agricultural Economy of the Hill Pagans of Dikwa Emirate, Cameroons. *Emp. Jour. Exp. Agric.* 9, 33, 65.

Thomas, A. S. (1940).—Grasses as Indicator Plants in Uganda. *E.A.A.J.* 6, 1, 22.

Wilson, S. G. (1941).—Agricultural Practices among the Angoni-Tumbuka tribes of Mzimba (Nyasaland). *E.A.A.J.* 7, 2, 89.

(*Received for publication on 4th November*, 1942)

SOIL-LESS CULTIVATION

A review of the recent progress in soil-less cultivation has recently been given by Prof. R. H. Stoughton (*J. Min. Agric.*, 49, 25; 1942). In spite of many misconceptions and difficulties steady progress has been made both in the laboratory and on small scale semi-commercial installations, and a stage appears to have been reached when some reliable judgment can be formed on the question. Two types of systems are in use: (1) in which the plants are grown in a tank of nutrient solution with the roots immersed in a liquid medium; (2) where the permanent sub-stratum is an inert material such as sand or gravel, to which nutrient solution is supplied at intervals. Carefully controlled trials have shown that in general the first of these is unsuitable for use in Great Britain, owing to the difficulty of securing adequate aeration for the roots, and the low light intensity. Far more promising results have been obtained with the second method, which may be considered under two main headings, namely sand and sub-irrigation culture. In sand culture the plants are fed by watering on the nutrient solution from above, the surplus liquid draining away. Tomatoes, chrysanthemums, lettuce and a wide range of vegetables gave very satisfactory crops under these conditions, and promising results have been obtained with carnations using a slightly modified and simplified technique.

The disadvantages of the system, however, are the care needed in the control of the moisture content of the medium, and wastage of materials through drainage, but these are to some extent offset by the small cost of the outlay compared with the sub-irrigation method. In the latter case, the nutrient solution is pumped at intervals from below into the growing tank until the gravel is flooded to the top, the pump is then shut off and the liquid flows back by gravity to the supply tank. The watering and feeding can thus be made almost automatic, the aeration of the medium is excellent and considerable economy in fertilizer materials is effected. Further, chemical sterilization of the gravel is easily carried out. To meet the criticism that soil-less cultivation results in crops of lower nutritional value, chemical analysis of the carbohydrate, protein, inorganic constituents and vitamin C content were carried out. No significant differences could be established between plants grown in gravel and those grown in soil. Experiments are now in progress at the Unversity of Reading, under a grant from the British Electrical and Allied Industries Research Association, to test, among other things, the effect of heating the solution in the sub-irrigation culture of tomatoes. Work is also proceeding on the chemical testing of the solution by simple colour tests, so that its composition may be readily controlled according to the requirements of the crops.

Nature, Vol. 150, page 174, August, 1942.

MARGINAL COSTS

By V. Liversage, Agricultural Economist, Department of Agriculture, Kenya

Many pronouncements made about costs of production, profit and loss have an air of unreality due to over-simplification. At the present time almost all economic activity is falling under official control; prices and margins in all directions are being laid down by official bodies and there was never a time when a sound knowledge of price-making forces was more desirable. The underlying philosophy of price-fixing is in a state of flux. Sometimes it tends in the direction of a "just price" conception, such as was characteristic of the middle ages, when the public had decided views as to what prices ought to be, when there were the Assize of Bread and the Assize of Ale, and when "engrossing" (cornering the market) and "regrating" (turning over at a profit without increasing the intrinsic value of the goods) were penal offences. At other times the aim is to set such prices as will just suffice to call forth the production or the services required, as when the price of maize and wheat is advanced to encourage greater production, but that of cotton is kept down to discourage increased production at the expense of crops more essential in present circumstances.

There is a fundamental difference between these two concepts. The first is based on sentiment, the second on expediency. The first concentrates on the rewards to those concerned, the second on the results to be achieved. The second avoids the arbitrary and far-reaching judgments necessary for the first; a bow can be drawn at a venture and by a process of successive approximation the first errors can be corrected. In the first method, however, the attempt to establish a "just price" results in all sorts of secondary reactions and in the end we come back to much the same process of trial and error in both cases.

Even in a process of trial and error, there is no sense in making greater errors than can be avoided. The first shots should be as near the target as possible, and to this end it is necessary to study the side winds that blow. If this is necessary for those administering public control it is no less necessary for producers, who may find themselves placed in circumstances to which their previous experience provides little guide.

Most people cling pathetically to that elusive conception *the* cost of production. It only remains to find this and compare it with the ruling price and, *voilà*, there is all you need to know. I pass over the difficulty of getting a single figure out of a multitude of variants, and investing it with a definite meaning. The average number of children in English families is, I believe, some fraction between two and three, but I have never seen a family of this size, except in the special sense that one member of the family may be not quite all there. This is merely a statistical difficulty, though no light one, and it is rather with the inner meaning of the word *cost* that this note is concerned.

The average ton-mile cost of carrying goods over the Kenya and Uganda Railway in 1940 was cents 9.529. A ton of maize carried from Kitale to Kilindini (628 miles) reckoned at this rate would cost Sh. 59/84, yet the railway carried it for Sh. 13/50. Was the railway therefore losing Sh. 46/34 on every ton of maize it carried at the export rate? By no means. The average ton-mile cost of cents 9.529 included cents 3.132 for loan charges. The loan money was already spent; it had been converted into permanent way, rolling stock and buildings, which, if they could be re-converted into cash at all, could not be disposed of at what they cost. For practical purposes the money could be regarded as irretrievably sunk. This cents 3.132 per ton-mile would not be recovered if maize were not carried, and in any important practical sense it was not an element in the cost of carrying maize to the coast for export. Deducting it, the cost of carrying a ton of maize from Kitale to the coast was Sh. 40/17, instead of Sh. 58/84. We are still a long way above Sh. 13/50. But again, we find that the total ton-mile cost included cents 1.204 for contribution to renewals fund, equivalent to Sh. 7/56 per ton from Kitale to the coast. If maize were not carried from Kitale would the cost of renewals on the railway as a whole be any the less? Probably, but it is difficult to say by how much. Some of the engines and wagons would last a little longer if they did not have to travel to Kitale. It would make no difference to the cost of erecting a new station building at Limuru, or of installing a new weighing

machine at the Nairobi Parcels Office. In short, the amount by which the cost of renewals on the railway would be reduced by cutting out export maize from Kitale is difficult to arrive at, but probably much less than the average ton-mile cost of renewals. Finally we come to the working costs. This includes a large number of items, which do not vary exactly with the number of ton-miles of traffic. If no export maize were carried from Kitale, would the railway be able to dispense with the services, salary and pension of one-quarter or one-half of the Kitale station master? Or some lesser fraction of the salary of the General Manager, Superintendent of the Line and Chief Engineer? Would the trains travel less frequently, or would the average train load be less? In the latter case the fuel necessary to propel the engine itself would be the same and so would the wages of the engine driver and fireman. The cost of repairing washaways on the line, the number of porters, signalmen, electricians, clerks and what not would be very much the same.

In short, it might easily happen that if the railway authorities refused to carry maize from Kitale at under "cost of production", the effect would be simply to cut out the receipts without effecting any recognizable diminution in the total railway costs. There are other factors to consider also. The elimination of export maize from Kitale might make maize growing unprofitable there and thus reduce the local maize traffic carried at taper rates varying between cents 22.4 per ton-mile and cents 14.1. These are profitable rates. The amount of whisky and cosmetics purchased by the maize farmers and their wives, and carried by the railway at high rates, might be reduced.

An analogous instance of connected traffic is seen in the cotton industry. Cotton seed is carried by the railway at Sh. 22/75 per ton from Kampala to the coast. This is equivalent to cents 2.97 per ton-mile. But cotton seed is inseparably connected with cotton fibre, which is carried over the same distance at Sh. 65/19 or cents 8.15 per ton-mile. If the railway refused to carry cotton seed at an unprofitable rate, and the growing of cotton were discontinued, there would be no fibre to carry at the cents 8.15 rate, which at least returns an appreciable surplus over average working costs.

Of course it does not follow that raising the rate will necessarily bring production to a standstill. The extent to which production will be carried on at any given railway rate must be estimated by the rate-fixing authority in order to arrive at the most profitable rate to charge. The extent to which *total* railway costs will be increased or diminished by any given increase or decrease in the traffic must then be estimated and balanced against the increase or decrease in total receipts.

We have now arrived at the meaning of the term *marginal*, as used in the terminology of economics. Unfortunately the word is used in two senses, and in order to explain these two different but connected meanings let us take two simpler illustrations.

Suppose a man has 100 acres of land and wishes to grow wheat on it. Assume that the oxen, gear and implements will be such as will necessitate a depreciation allowance of £50 a year and that the running costs are limited to seed, labour and twine, working out at a level Sh. 30 per acre (an assumption chosen for simplicity and not likely to work out in practice). The first acre will then cost Sh. 1,030 and each subsequent acre only Sh. 30 extra. That is to say, the marginal cost of growing one acre under these conditions would be no less than Sh. 1,030 and that of the second and each subsequent acre only Sh. 30.

That is one sense in which the term "marginal" is used. There is another sense. The farmer would want to know how many acres he would have to grow before a profit became visible. Suppose he could expect to get three bags per acre and sell them at Sh. 23 per bag, a total of Sh. 69 per acre. His costs, returns and profit or loss would then work out as follows (in order to reduce the length of the table we can confine ourselves to the part where loss passes into profit):—

Cost	Number of Acres Grown				
	23	24	25	26	27
	Sh.	*Sh.*	*Sh.*	*Sh.*	*Sh.*
Fixed ..	1,000	1,000	1,000	1,000	1,000
Variable ..	690	720	750	780	810
Total ..	1,690	1,720	1,750	1,780	1,810
Cost per acre	73/50	71/70	70	68/50	67

Comparing the costs per acre with the Sh. 69 receipts per acre, in this particular assumed case it would not pay to grow less than 26 acres. The 26th is the "marginal acre".

In this illustration we have a case where increasing economic returns apply. Sometimes we have to deal with cases subject to the so-

called Law of Diminishing Returns. Here the same method of analysis can be used, but the results work out in the opposite direction. A common illustration is the use of fertilizer on crops. Small dressings may give a handsome return in increased yields per unit of fertilizer used. Additional dressings, though resulting in a higher total yield per acre, give a lower increase per unit of fertilizer used, until the last additional cwt. or ton to the acre fails to give an increase sufficient to cover its cost. The last cwt. or ton which gives a return above its cost is the marginal application.

We speak of marginal wheat land, meaning that which is only just worth while putting under wheat, of marginal land as that which is only just worth farming at all. Land which is on the margin for wheat may be above the margin for dairying, land below the margin for dairying above the margin for sheep, land below the margin for farming above the margin for forestry. Land which is below the margin at one level of prices may rise above it if produce prices rise faster than costs, or, if costs rise faster than prices may sink below it.

The position of the margin differs according to the circumstances. If, in the example given above, the farmer had no land and was considering whether to buy land for the purpose, he would have had to take the cost of the land into his calculations, and the margin would have worked out at a higher acreage. If, on the other hand, he had both land and implements he could have left the land and implements out of his calculations, except so far as he had the alternative of selling them.

This illustrates why producers are often willing to go on producing when prices are below costs as computed by an accountant. The marginal cost may differ widely from the accounting cost. If a farmer has the land and the machinery, and does not want to or cannot sell them, the marginal cost of some crop to him is confined to the extra cost of labour, repairs and materials, combined with the amount which he considers necessary to insure him against risk of loss and to reward him for his extra work.

Cognizance must be taken of these basic springs of economic activity. It is all very well to say that people will not produce unless they can in the long run cover their total costs with a margin to spare, and that therefore prices must be fixed high enough to give this result. Unless we are prepared to say exactly what and how much must be produced, and where, we must take into account what people are going to do in the short run. It will be obvious that, in industries subject to increasing returns, if a grower can come out on the right side at 26 acres it will pay him to put in more acres, and in nine cases out of ten he will probably do so. A few wheat growers might be able to sell their combines and get out of wheat production if not satisfied, but they could not all do so because combines are not used for most other crops. The net result is that at any given time there are a considerable proportion of farmers producing, or prepared to produce, at less than computed costs (including reward for risk and management).

Examples of the difference between accounting costs and marginal costs are abundant in every-day life. Some Government officers used to consider (before the war) that the rate allowed for using a motor car on official business involved them in loss. They claimed that their average cost per mile, including depreciation, tax and insurance, was well above the figure allowed. Others said they were quite content, because they would have had a car in any case, and would have bought a new one when it was out of date; they would have been paying insurance and tax in any case. Therefore, if the travelling allowance left something over after covering the cost of petrol, oil and wear and tear, this was so much to the good. Others said that if they had had no official running to do they would have had a smaller car and made it last longer, but if they could anticipate enough official running to support a big car and change it every three or four years, the personal satisfaction would be worth something. In this case there was no element of competition, so that the marginal costs did not play any part in influencing the rate for running on official business, but who can doubt that if it had been a matter of individual bargaining these factors would have played their part? In Mombasa some time ago it was often possible to travel by taxicab at much lower rates than is the case to-day. If a driver whose stand was at the railway station took a party thence to the port, any fare for the return journey would be better than none, and very low rates were sometimes quoted. Occasionally a taxicab in the town, seeing a person waiting for a bus, would offer to drive him for the bus fare, calculating that it would at least leave a profit over the cost of the petrol. In India there were, before the war, large numbers of buses and lorries plying for low fares. A common arrangement was that an owner-driver

obtained a lorry or bus on the hire-purchase system and insured it with the seller. Out of his fares he paid the running costs and repayment instalments. He probably slept in it and may have had sufficient mechanical knowledge to effect repairs for himself. By the time he had completed the hire-purchase payments the vehicle was probably fit only for the scrap heap, so the process would be repeated. If the owner made in this way more than he could earn as an employee, and in addition had the satisfaction of being his own master, he was content. The system no doubt increased the cost of road maintenance and gave the railways something to puzzle over, but it also provided cheap transport from village to village and town to town for people and goods. The firms selling and insuring the motor vehicles probably had no great objection to it. In Nigeria, too, a similar practice was followed. Natives bought lorries on the instalment plan from the firms selling goods. They carried trade goods outwards, and on the return journey carried produce for any rate from 2d. to 6d. per ton-mile. They thus helped the sales of trade goods, provided cheap transport for produce, and incidentally provided a market for lorries. Obviously an *ad hoc* transport agency financed on company lines could not compete, and a Kenya committee on transport problems in attempting to construct a case for control of free-lance road transport had to fall back on criticisms of the service rendered.

In Kenya, maize which would not ordinarily pay for carrying by road is brought to Nairobi by lorries which are taking trade goods in the reserve direction and would otherwise have to travel empty. In England, pantechnicons delivering furniture to distant parts of the country used to advertise space on the return journey and were prepared to accept whatever they could get for space which would otherwise be empty. The trade in board-residence all over the world is dominated by the marginal costs of spare rooms and extra meals.

Before the war one often came across cost studies of farming showing that the business was being carried on at a loss. This sometimes arose from the difficulty of apportioning the costs on mixed farms between the various lines of production. Any attempt to do this gave an appearance of unreality to the figures and deprived them of practical significance. But the same thing occurs in one-line businesses. A study of cotton ginning in India showed that the prevailing charges in many areas were below the computed costs of production. In East Africa competition between cotton ginning firms has been restrained. A considerable proportion of the costs of ginning are not increased if the amount of cotton handled is increased, up to the capacity of the plant. The ginning firms generally bought the seed cotton outright, ginned and sold it to exporting firms. In order to bring more cotton to the gins it paid them to offer higher prices in the areas further away from their own ginnery and nearer to other ginneries, particularly as, owing to the cost of transport, this could often be done without affecting the price of cotton near their own ginnery. The result was described as "cut throat competition" and "chaos". It was supposed that the ginning firms must have covered their costs by devious practices and that owing to the erection of too many ginneries and consequent smaller turnover costs must have actually increased. From what has been said it will be clear that the practice was normal. By introducing control the influence of marginal costs was eliminated and established ginners were enabled to work on a higher margin than under competitive conditions they would have been prepared to do. The contrast between ginning margins in East Africa and other parts of the world suggests that theoretical expectation is fully borne out by practical experience.

Competition on the basis of marginal costs certainly introduces irregularity, in the sense that marginal costs are not the same for any two firms, or in any two places at the same time or at different times in the same place. It might be considered desirable on general grounds to remove this irregularity. But if this is done the public must pay the price. Not only would some producers receive an increased return, but the cost of distribution, already high, would be further increased unless countervailing economies could be effected. Producers as a whole would have to submit to production control in order to curb the activities of those whose marginal costs were specially low.

The theory of marginal costs enables us to make a more realistic approach to the problems of everyday life. During the war the problem of directing production into the desired channels through the medium of the price structure has been to the fore, particularly as regards native agriculture. As a starting point it seemed useful to estimate the amount of time required to grow the various crops and to put a value on it, adding any other costs incurred. It was comparatively easy to draw up a cost schedule, such as the following:—

MAIZE : Per Acre :—	*Sh.*	*cts*
100 man-hours at 5 cents	5	00
200 woman-hours at 4 cents	8	00
100 child-hours at 2½ cents	2	50
Cost of seed—20 lb. at Sh. 5 per 200 lb.		50
Depreciation and upkeep of tools, etc. ..	1	50
Sh.	17	50

At four bags per acre, cost=Sh. 4/38 per 200 lb. Sold at Sh. 4/90, profit=52 cents per 200 lb. or Sh. 2/08 per acre.

But what does this mean? Does it mean that a native family is precisely Sh. 2/08 better off for each acre of maize that it grows? Does it mean that its expenditure would be less by Sh. 17/50 for each acre of maize that it did not grow? These questions have only to be asked for their absurdity to be revealed.

The cost schedule would have no greater validity if it were based on the most meticulous recording and drawn up under the imposing letter-head of a firm of chartered accountants. The facts are plain. African families usually contain women and children, and these, if they are not working in the fields, are not usually earning money in any other way. In other words, the alternative value of woman and child labour is negligible. The marginal cost of having a wife and child working in the fields is practically nil. The man might otherwise be away earning money on a European-owned farm or in a town, so that working on his own holding might entail the sacrifice of wages. But it is by no means always so. Some of the men are too old to go out to work but are yet able to do some work on the family holding. It is inconceivable that all the able-bodied men should be absent from their locations all the time. Some time must be spent with their families, and what is the extra cost of working rather than idling when they are at home? On the other hand, the recorded work hours might entail a sacrifice of much more time. As an agricultural officer pointed out, "Though the labour-hours required to produce a crop may be computed, as, say, 100 hours, the grower is actually tied to the land during the preparation for and production of that crop for periods of time when he is not actively engaged on that crop at all. For instance, land is broken. After breaking it is left for periods of time varying from a week to three weeks. Yet the grower is unable to find any other occupation in the short time available to him". In this case the real cost is greater than the accounting cost, at least as it would be computed on conventional lines.

There is another sense in which accounting methods fail to provide an estimate of economic incentives. An African peasant may well prefer those crops which give a greater return per hour of work performed, but a great deal will depend on when that work is necessary. Some crops require labour for preparation of the land, seeding and harvesting at the same time. Such crops are competitive for labour, and there is a limit to the acreage which can be managed by the family. Other crops require labour at different times and are non-competitive as regards labour. In between the periods of heavy work on the first category there are slack periods. If idle time in these periods can be used on supplementary crops the value of the time so used will appear quite different from that used in the rush periods. It may in fact appear that anything earned in this way from supplementary crops is something for nothing, i.e. that the marginal cost of labour in slack periods is nil. This consideration is especially important in British agriculture, where labour is usually employed on a yearly and not a weekly, daily or hourly basis. Take the case of a grass dairy farm with a few acres under root crops for winter feeding. Cost accounts will show a high labour cost for the root acreage. But the minimum labour force on the farm will be determined by the size of the dairy herd, which must be milked between certain hours every day. Any acreage of roots which can be handled between milkings by this labour force will certainly require more labour per acre than the grassland, but it will not cost the farmer any more. The marginal labour cost of substituting roots for grass will be nil. This explains why cost accounting has not gone far in explaining the economics of mixed farming. It also explains why in countries where most of the labour is done by the farmer's family, or by workers employed on a permanent basis, mixed farming is the rule. Success depends on devising a system which provides income-earning work for the labour force for as much of the time as possible throughout the day and year. One-crop farming would involve disastrous waste of time and wages. In Africa it can be followed only because labour can be "stood off" when not required.

(*Received for publication on 23rd November, 1942*)

TERMITES IN EAST AFRICA*

iV—TERMITES AND BUILDINGS

By W. Victor Harris, Entomologist, Department of Agriculture, Tanganyika Territory

According to their particular mode of life, termites fall into the following three distinct groups:—

I. Mound-building or ground-nesting termites who construct protective runways of earth leading from their nest to supplies of cellulose, including the timber of buildings. This cellulose is used to make fungus gardens in the nest to provide the food supply for the colony. In this group there are no subsidiary or colonial nurseries away from the main nest and nearer to temporary food supplies. All movement away from the nest is for the purpose of foraging, and on the outward journeys earth is often taken from excavations in the soil and dumped in cavities in attacked timber.

II. Subterranean termites who never construct runways of earth or carry earth into excavations in timber. They do not make fungus gardens in the nest but digest cellulose direct with the aid of protozoa living in their gut, or after it has been partially changed by fungi in the timber. These termites are capable of moving considerable distances through earth walls to reach suitable well-seasoned timber. Colonial nurseries may be found at some distance from the main nest, but contact with the latter must be maintained to keep up the supply of eggs, there being no queens in such nurseries.

III. Dry-wood termites whose nest is situated in timber remote from the ground, and whose activities, except for the brief period when males and females fly off to found new nests, are confined to tunnels inside this timber. There is no connexion with the ground whatever in this group. The number of individual termites in a colony of this group is very small in comparison with the large populations of nests belonging to the two preceding groups.

When considering the protection of buildings or the control of termites already attacking them and the furniture they contain, it is essential to keep in mind that there are these three groups with widely differing habits. It is useful to realize this, too, when reading of termite control measures employed with success in other continents, and so to avoid taking precautions against types of termites which may be rare in East Africa while neglecting measures more suited to the types we have.

Mound-building Termites

To this group belong the termites most commonly found attacking buildings and furniture in East Africa. One or more species are to be found in practically all situations from sea-level to 8,000 feet, except where the soil is but a thin layer over a rocky outcrop, where flooding is regular, or where the ground is covered with dense rain forest. Mounds are not always noticeable because conditions may be unfavourable for their construction; for example, where friable soil cannot be made to withstand heavy rains, or where low temperatures during the cold season approach the danger point, causing the termites to make their nests well below the surface for greater protection. Some termites are disinclined towards mound building, others quite decidedly never try, but all members of this group agree in building runways of earth in which to pass in safety over exposed surfaces between the ground and the timber being attacked, in attacking timber from within and under cover of sheets of earth, and in filling up their workings in timber with earth brought up from underground excavations. These termites appear to be most numerous in red soils of the so-called lateritic type in our drier areas. Cellulose is a necessity for them in order that they can make honey-combed fungus gardens to provide food for the young stages and the reproductives, and they will go to great lengths to get it. The unprotected timberwork of buildings, furniture and fittings provides easily worked food supplies to maintain large colonies of termites.

The large mound-builders of the genus *Bellicositermes* are our most obvious termites, both on account of the large size of the mounds they build and because their soldiers are so big, but they are not the most destructive to buildings, unless of the "wattle-and-daub" or "green brick without foundation" types. Of more importance is the genus *Termes*, with smaller soldiers and less conspicuous mounds (or none at all). Probably the most dangerous of all are members of the third

* For the first three parts in this series see Vol. 6, p. 62, p. 67, p. 201.

genus *Microtermes,* because they are even smaller and much less conspicuous. They, too, collect cellulose for fungus gardens, but are less inclined to build mounds above ground level. Their earth runs up walls are less in diameter than a pencil, and frequently flattened in section, and in addition they rarely coalesce to form protective sheets of earth over timber being attacked.

Subterranean Termites

The East African subterranean termite associated with buildings, *Coptotermes amanii,* has a preference for old, well-dried timber, and is not so obviously encouraged by damp as are many of the more injurious American forms. Nevertheless, it requires timber to be in contact with earth, either the soil direct or via mud bricks or mud mortar, because the primary nest is underground. This termite differs from the mound builders in that it does not construct earth tunnels in which to pass from the soil in which its nest is situated to the timberwork to be attacked. It must move through earth or wood; hence the necessity for the contact between soil and timber as stated. As a result, the mound-builder, in short-circuiting a stretch of unproductive wall, builds a tell-tale length of earthen runway, but the subterranean termite gives no such warning of its presence, but works its way along inside the structure. Woodwork eaten out by *Coptotermes* is not used as a dump for earth from subterranean excavations. Thin plates of wood are left running parallel with the grain to support the outer layer of timber left uneaten, and if any extra construction work is needed it is done with chewed wood pulp, which dries as a rule a light colour and produces a spotted effect in injured timber. The damage done by this termite is commonly ascribed to dry rot.

Dry-wood Termites

These termites produce an effect similar to such wood borers as the "death watch" and "powder post" beetles. The adult termites fly to a suitable beam or rafter and begin to bore. The colony develops there and the history of the nest is passed without any connexion with the earth. In many parts of the tropics this group of termites is the main source of damage to buildings, but not in East Africa. I know of three records only of such damage: *Cryptotermes havilandi* is recorded by Sjöstedt in his monograph on the African termites from Mombasa, while specimens collected by Dr. R. R. Scott in 1935 attacking furniture in Dar es Salaam were ascribed to the same species by the British Museum. Termites found boring in stored timber in Tanga some years ago also belong to this or a closely allied species. The fact that all these records come from ports suggests that they are the result of accidental introductions, as *C. havilandi* is found at a number of localities on the West Coast. Such introductions have occurred with related termites in Durban from the West Indies, and in Mauritius from the Philippines.

The absence of this group of termites from our buildings simplifies enormously the question of control, as the attack has to be faced in one direction only, from the ground, and not in addition from the air.

The following are the species of termites so far found to be most commonly involved in damage to buildings:—

Bellicositermes bellicosus. — Builds large mounds, domed or pointed according to soil conditions; constructs broad covered ways to reach food supplies, preferably of coarse red soil; usually only attacks buildings of mud and poles, or green brick without stone foundations; removes timber completely; in buildings of green brick it shows a tendency to construct large bulges of damp earth on the inner faces of the walls, often at night-time. All castes are large; the biggest soldiers rarely leave the nests; the smaller soldiers can be recognized by having smooth, unserrated mandibles or jaws.

Termes badius.—More inclined to construct very low mounds with large funnel-like openings, unless in the shelter of a boulder or a tree with large buttresses; soldiers not so large as *bellicosus,* and with small projecting teeth on the inner edges of the mandibles; shows a liking for cement or flagged flooring as shelter for the nest, and in consequence is found attacking a building from within the limits of the foundation, and coming up through cracks in the floor; it is not so persistent in prospecting walls of burnt brick or stone with cement mortar as the following species.

Microtermes redenianus.—A small termite, with underground nests; makes narrow, straight earth runways up the surface of walls to reach unprotected woodwork; will work up through earth mortar walls a distance of sixteen feet to attack roof timber; owing to the small apertures through which it can pass, and the persistence of its exploration, this termite is considered the most dangerous of its group; other species of the genus may prove to be equally injurious.

TERMITE DAMAGE TO TIMBERWORK OF BUILDINGS

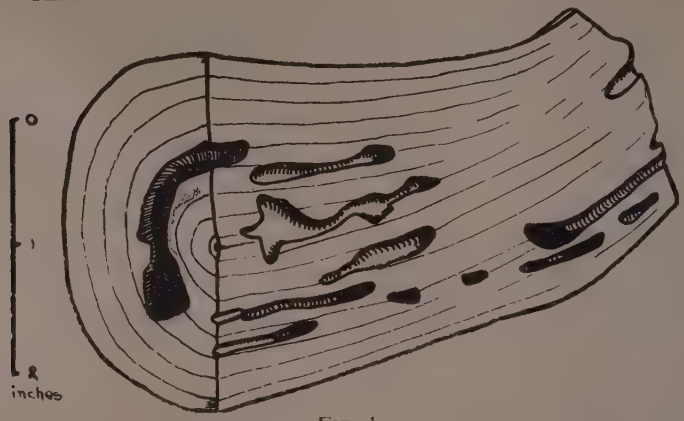


FIG. 1
Dry-wood termite (*Cryptotermes*) workings in roof pole.

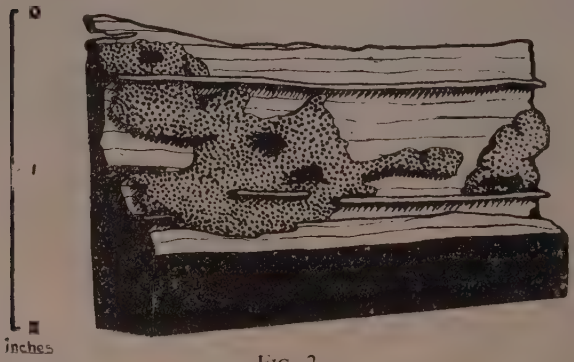


FIG. 2
Microtermes damage to door of imported timber, painted but not treated.

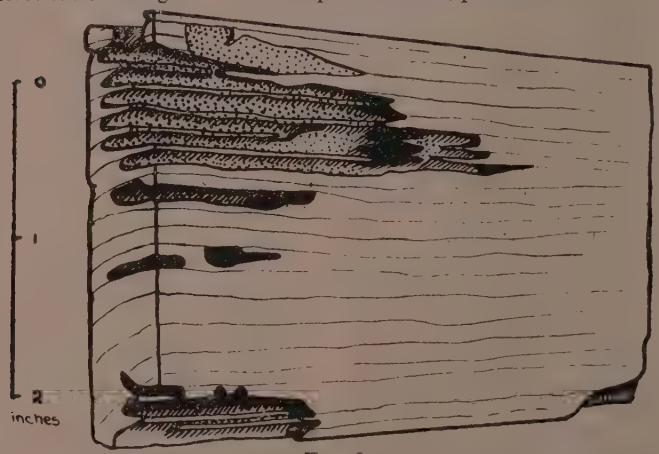


FIG. 3
Coptotermes amanii damage to untreated imported ceiling boards.

Coptotermes amanii.—Nests below ground; difficult to find; does not make fungus comb; must have timber touching the ground or on walls containing earth mortar; will penetrate suitable walls to a height of forty feet to attack ceilings and roof timber; common in most old buildings along the coast and hinterland; damaged timber has laminated structure usually called dry rot; imported ceiling-boards are especially hard hit.

Control Measures

As usual, prevention is better than cure in regard to termite attack in buildings, and moreover the chances of cure are so small that prevention becomes especially important. Control falls under four heads, viz. the termite-proof construction of buildings; the use of timber resistant to termite attack; the clearance of the site prior to building; and, finally, measures to reduce the effects of termite invasion.

The Termite-proof Construction of Buildings

A building constructed of stone or burnt brick and cement mortar should not become infested with termites in East Africa, where dry-wood termites are practically unknown and where the sole source of danger thus lies in the ground. Imperfections in building technique, however, lead to cracks in walls as foundations subside unevenly, and more commonly to cracks where cement floors meet walls as the earth filling settles. To safeguard against these faults and to preserve an unbroken barrier against termites certain precautions may be taken. Among the recommendations made by the American Termite Investigations Committee (Kofoid, 1934), we find the following:

> "All foundation walls and piers shall be of concrete or of masonry laid in Portland cement mortar, and shall extend at all points at least six inches above the finished grade. Masonry or concrete foundation walls shall extend at least as high as the top of any adjacent concrete or masonry slab which is supported by either natural ground or an earth fill. All foundation walls shall be reinforced with not less than two steel rods, three-eighths inch in diameter, placed not more than four inches below the top of the wall. Such reinforcing shall be continuous throughout the length of every wall and around all corners."

In Natal (du Plessis, 1935), the Public Works Department puts suspended reinforced concrete floors in buildings instead of the usual concrete on earth filling, and in addition a termite-proof course of galvanized iron is built into all foundation walls as follows:—

> "Build into foundation walls on all sides under all floors and cover the whole of the sleeper walls with a termite course of 24-gauge galvanized sheet iron as described, lapped, riveted, and soldered at seams.
>
> The termite course is to be built 4½ inches into external walls and veranda foot walls, and full width of sleeper walls, and three inches under all floors, slightly turned down, and to be returned into reveals of access openings.
>
> The termite course is to be bedded in 5 to 1 cement mortar and the two brick courses above to be built and flushed up solid in similar mortar, so as to leave no crack for the termite."

Where constructional methods leave no room for doubts about cracking, a combined termite- and damp-proof course, three inches deep and projecting not less than three inches on each side of the wall, can be employed. It is usual to add a water-proofing material to the concrete or a layer of bitumastic material along the top. Without the metal shield on the inner face, the laying of the cement floor in such a manner that no cracks will subsequently appear near the walls becomes a matter of some practical skill. In Ceylon (Jepson, 1929), this termite-proof course has been adopted for use in all Government buildings. The same writer refers to the method of laying floors and barrier in one unbroken course right over the entire site after the foundation walls have been raised to the desired height. This has the drawback that laying the floor in the early stages of building renders it liable to damage later on during the constructional period. Further, "a well laid concrete floor should be surface-rendered before the concrete sets, and when this operation is carried out at a later stage there is not as satisfactory a blending of the cement surfaces as when the two operations are performed more or less simultaneously." This method of construction is useful where it is necessary to use sun-dried bricks for walls above the foundations, and it has been observed that where only small buildings are being constructed little damage need be done to the floors.

Having achieved a building which is isolated from termites in the ground by means of an "ant-proof course" on all the foundations

(either metal strip or unbroken concrete slab), and with concrete floors laid so that there will be no cracking, care must be taken not to spoil this effect by thoughtless embellishments or by subsequent amateur alterations and additions. Such extras may easily provide a bridge over the termite-proofing to allow of the building of exploratory runways to reach the woodwork, or, if of timber, to provide a route for *Coptotermes*. Specific examples of termites gaining access to buildings in this way that have come to our notice include:—Verandah steps, without a termite-proof course of their own, joining building above its protective course; lean-to hot-water boiler built of stone and mud-mortar without concrete course; existing verandah widened, the new floor subsiding owing to careless filling, and the cracks giving access to termites around the new foundations and along the sleeper wall; timber trellis work on exterior wall, to support creepers, extending from below soil level to the projecting roof timbers.

Timber resistant to Termite attack

Some timbers are naturally resistant to termite attack, others may be made so by impregnation with suitable chemicals. This question of resistance is not such a straightforward matter as would appear at first sight. Reference has already been made above to the great difference in feeding habits of our two main types of timber-destroying termites, how *Termes* and its allies collect cellulose in order to grow fungi on it for food, and how *Coptotermes* digests it direct with the assistance of protozoa living in its gut and possibly after it has been partially broken down already by fungi. In practice, too, it is often difficult to decide how far the initial damage has been done by rotting, or to what extent rotting has followed on termite damage. As a result, the usual "graveyard" method of experimentally determining resistance by sticking samples of timber in ground infested by termites requires careful analysis. Not only is it advisable to know the kinds of termites at work in the "graveyard", but timber to be used near the coast will require to be tested with *Coptotermes* before it can really be called resistant.

Natural resistance is a property found in varying degree in the heart woods of certain species of trees. Teak is one of the best known resistant trees. In most tropical countries attempts have been made to assess this property in the local timbers. Sangster (1942) gives a detailed account of experiments carried out in Uganda, where the following are the more durable timbers:—*Albizzia coriaria, Chlorophora excelsa, Cynometra alexandri, Erythropleum guineense* and *Mildbraediodendron excelsum.* Of these, the *Chlorophora* (*mvule* or *iroko*) is the most widely known as a timber and its termite resistance has long been made use of throughout Tropical Africa. Fuller (1924) gives an account of experiments carried out at Durban, where *Pterocarpus angolensis* (*minga*) was among the more resistant timbers used. In most experiments of this nature rotting is an important factor in the failure of test timbers and it is difficult at times to evaluate the real termite damage.

Resistance is of greater importance in timber and poles used in the construction of buildings of the less expensive types such as huts, farm buildings, etc., than in those which may be reasonably expected to have ant-proof courses and well laid concrete floors. Under certain circumstances, for example in maize cribs with raised flooring, it may be possible to utilize a wood for the main supports entering the ground that is not suitable for general timberwork and to employ in the superstructure a more workable timber which is resistant to termites but which is liable to rotting in the ground. Sangster (*loc. cit.*) deals with the suitability of poles in Uganda. Among the trees considered immune to termites in Ceylon (Jepson, 1929), which are of interest here, are *Borassus flabellifer,* female tree (*mvumo*), *Artocarpus integrifolia* (Jak, *mfenesi*) and *Thespesia populnea* (*mtakawa*). *Tamarindus indica* (*mkwaju*) is listed by Jepson as resistant to termites.

Chemical treatment of timber will make it resistant to termite attack. At the same time resistance to rotting is usually achieved, so that the term "wood preservative" can be used for the chemical employed. A practical wood preservative should be cheap, long-lasting, deep-penetrating, without ill effect on the timber or those who handle it after treatment, and for certain purposes should not interfere with subsequent painting of the work. Coal-tar creosote was one of the earliest substances used as a wood preservative and it is still one of the best. Its disadvantages are its colour, its smell and the way in which it prevents wood being painted. Many other substances have been tried, and among those which have given the best results are compounds of arsenic and the metallic fluorides. The effect of these substances is to cover the timber with a protective skin of poisonous or non-attractive treated

wood, and to give good results this skin must be maintained unbroken. Thus it becomes just as important that a wood preservative should be properly used as it should be properly chosen. Soft woods absorb preservative better than do harder woods and particularly heart woods. Preservatives themselves vary greatly in their ability to penetrate the wood cells. Then there are different ways in which the preservative can be applied. From figures given in Kofoid (1934) the amount of preservative which can be put into timber varies from half a pound per cubic foot by careful application with a brush, to 35 pounds per cubic foot when the timber is heated with the preservative under pressure. Intermediate results are obtained by soaking the wood in open tanks of preservative for a suitable length of time, details of which are to be found in a number of publications. In all methods the point which must be watched is that treatment must follow any cutting or other working of the wood. It is no use whatever jointing creosoted roof timbers without again soaking the cut ends before they are nailed together. Creosoting will not stop termites building their earth runways along the outside of timber until they find a point where the protective skin has been broken, either by sawing or nailing or a careless hammer blow. The thicker the protective layer is, the less likely are the termites to find a way in, and for this reason wood treated by the tank method is to be preferred to that which has the preservative applied by brushing. As a final point it may be mentioned that the penetration of unseasoned wood is poor, and this is a common cause of failure particularly in the use of bush poles.

Site Clearance

It is a good thing to clear all the termite nests possible from the site of any type of building. A new colony of *Bellicositermes* and the larger *Termes* takes a year or more to establish itself, and much longer to become really injurious. If the apparatus is available, the nests of these mound-building or funnel-constructing species can be rapidly destroyed by fumigation with calcium cyanamide powder, which, in contact with soil moisture, liberates hydrocyanic acid gas, or with the arsenical fumes generated in a "Four Oaks" white-ant exterminator. A simple method which does not involve extra equipment and which has given excellent results in Tanganyika was described by Jepson (1931). In this method petrol is used and its effect is due more to the fact that petrol vapour destroys the fungus gardens of the termites most effectively, than to the actual killing of the individual insects. The method is as follows:—

> "The mounds are first levelled to the ground if they form an obstruction which it is desired to remove. This may be effected with a pickaxe and mamoty, but if the mounds are large their demolition may be accelerated by blasting. A series of holes should then be driven into the area previously covered by the mound with the aid of an avalangoe, the depth of the holes being about 18 inches and their number depending upon the area concerned. In the writer's experience, the diameter of a large mound in Ceylon rarely exceeds eight feet at the base, but the average diameter may be considered to more nearly approximate half this width. As the ground has been considerably undermined little resistance will be offered to the passage of the avalangoe. One hole should be made in the centre of the area previously occupied by the mound. This operation is not always necessary as a large hole will often be found in this situation, being the entrance to the ventilating flue with which most mounds are provided to supply air to the subterranean abodes of these species of termites. A circle of holes should then be made around the centre about 18 inches apart and about equidistant between the centre and the circumference of the area to be dealt with. Into each hole should then be poured, through a long-necked funnel, one ounce of petrol, the hole being immediately plugged with well-rammed soil to prevent the escape of the petrol vapour. An average-sized nest should not require more than 10–12 oz. of petrol and a large number of nests can be treated daily by one man, providing they are not situated too far apart. The cost of the preparatory operation of demolishing the mounds will depend on their size and the methods employed."

Digging out the queens is not such an effective method of clearing away termites as many people think. The larger mound builders are able to develop "substitution queens" unless the nest is most thoroughly destroyed, or have more than one queen in a nest system so that the colony can survive the removal of one of them.

Control of Termites in Buildings

The extent to which termites may be kept under control once a building has become infested depends on the type of building. Providing the attack does not come from

inside the foundations of the building the following method may be employed, as used in the Philippines (Uichanco, 1931):—

"During the past two years another method has been used by us in ridding the buildings . . . . of underground termites which from time to time build their tunnels up along the concrete walls to the wooden parts above. One of these species was *Coptotermes vastator,* a very destructive and not easily controlled pest. Repeated trials to locate the nest of that particular colony had failed, we had dug up the ground for a depth of one and a half metres along the base of the wall where the tunnels had their connection, but without success. . . . . The other infestations were by a species of *Termes,* two of which occurred on the wooden posts of the garage which were set in the ground and the rest in the building proper, as in *Coptotermes.* The procedure we finally adopted was as follows:— A shallow trench was dug in the soil where the termite tunnels were connected. This was then filled with water until the soil was so thoroughly drenched that absorption became very slow. If the place was near the faucet, a rubber hose was used; otherwise water was carried in pails. Enough waste engine oil (such as that drained from the crankcase of motor cars) or kerosene was then poured into the trench to make a very thick film on the surface of the water. As the water soaked downwards the oil was drawn by surface tension under the ground and through the communication galleries of the termites into the nest. Previous trials with oil alone, without water had failed because the oil did not penetrate into the soil well enough to reach the main termite colonies, and, besides the fact that more oil had to be used, the treatment resulted in merely shifting the direction of the march of the ravages. In our trial with this method, both in the case of *Termes* and the persistent *Coptotermes,* one treatment was found sufficient to destroy an entire colony."

As Uichanco remarks, mineral oil should not be used within reach of trees or valuable plants.

Termites building earth runways through cracks in floors and walls inside buildings in search of vulnerable woodwork may be kept at bay, if not altogether destroyed, by the use of Paris Green. This is a fine powder containing arsenic which is commonly used to control pests in gardens. Its bright colour makes its misuse much more unlikely than in the case of most other poisonous substances. A very small amount of Paris Green is inserted into the runways as they are discovered, or sprinkled along cracks through which they may be expected to appear. This is picked up by the passing termites, who then proceed to clean themselves, and thus get the poison into their stomachs. Their death is not instantaneous and, dying in or about the nest, the poison is passed on to the scavenger termites, whose job it is to remove the bodies by eating them, and so on. At any rate that is the theory, and in practice there is no doubt that termite activity in buildings can be mitigated by thorough use of Paris Green, particularly in that period just before the rains, when house-infesting species seem to be most active.

Repairs to timber work in termite-infested buildings should be carried out with wood that is either naturally resistant, or has been treated efficiently with preservative. Damage done by *Coptotermes amanii* is frequently called "dry rot" and all too often imported ceiling boards and timber are used in repair work with the merest dab of creosote applied to the exposed surfaces, or even without this. Furniture for houses likely to become infected with termites should be made entirely of *mvule* or other resistant timber, free from sapwood. Plywood backs should be avoided and care taken that no imported soft wood is used for corner supports or battens.

REFERENCES

Kofoid, C. A., *et. al.* (1934).—Termites and Termite Control. Berkley, Cal.

Du Plessis (1935).—Termites in Buildings. *Farming in South Africa,* Oct., 1935.

Jepson, F. P. (1929).—Termite-proof Construction of Buildings in Ceylon. *Dept. Agr. Ceylon, Bull.* 85.

Sangster, R. G. (1942).—Durability of some Uganda Timbers and Poles in the Ground. *E.A. Agr. Journal,* VII.

Fuller, C. (1924).—White Ant Experiments. *Dept. Agr. S. Africa Ent. Mem.* 2.

Jepson, F. P. (1931).—Note on the Destruction of the Nests of Mound-building Termites. *Trop. Agriculturist,* LXXVI.

Uichanco, L. B. (1931).—Water and Oil Treatment against Soil-inhabiting Termites. *Philippine Agriculturist,* XIX.

(Received for publication on 16th November, 1942)

MANUFACTURE OF ACETIC ACID ON RUBBER ESTATES FOR USE AS A COAGULANT

By C. G. Hansford and W. S. Martin, Uganda Department of Agriculture

Under war-time conditions the importation of pure acetic acid for use as a coagulant for rubber has become unreliable and a search has been made for a process for manufacture of a suitable coagulant locally. An investigation of local fermented liquors such as banana beer and sugar-cane juice failed to provide a culture of acetic acid bacteria suitable for use on a factory scale. Cultures were eventually obtained from vinegar and from imported dried fruits, while others were supplied by Dr. Nattrass from the Scott Agricultural Laboratories.

Raw materials for fermentation are easily procurable in East Africa, and the most convenient in most areas is molasses from the sugar factories, most of which make no use of this waste product. An investigation of a large number of yeast cultures from local and outside sources has shown that the most suitable is a culture of wine yeast imported from California and supplied to us by Dr. Nattrass, labelled No. 57. This ferments a liquor made from one part of molasses to 3½ parts of water (23–24° Brix) in three and a half days and produces about 6 per cent alcohol in the fermented liquor. In sterile cultures this alcohol content is raised as high as 8 per cent, but this is not obtained on a large scale without sterilization.

A modification of the quick vinegar process used in Europe for acetic acid manufacture has been developed for use on rubber estates. The essentials of the apparatus are given in the attached drawings. The acetifying column consists of three or four lengths of bamboo, the internal diameter being about three inches, the larger the better. The partitions in the bamboo are pierced by an iron bar, but remain as constrictions inside the tube, and assist in keeping the packing in place. For packing the column wood wool was first used, but this suffers from the disadvantage that in time it becomes soft and collects in a thick mass at the bottom of each joint of the bamboo column. A better material is split stems of dried elephant grass in lengths of 2–3 inches, packed loosely in the bamboo. Each joint of the bamboo is pierced by about 20 scattered holes of ⅜ to ½ inch diameter, bored at a downward angle of about 45°, so that the liquor in the column will not run outside the bamboo. To prevent the growth of large numbers of *Drosophila* fruit flies the column should be enclosed in *americani* cloth.

To start the acetifier column working a culture of acetic acid bacteria must be added to the alcoholic liquor after the first fermentation is completed. Such a culture can be obtained from ourselves or from Dr. Nattrass, Scott Agricultural Laboratories, Nairobi. The liquor with the culture added is allowed to trickle down the inside of the bamboo column, which should be at least 8 ft. long, at the rate of about two to three gallons per day; after all has passed through the column once, it should be returned to the upper tank and the process repeated, until all the liquor has been passed through the column four or five times, when the filling should be thoroughly impregnated with the acetic bacteria, and the liquor contain about 5 per cent acetic acid. Later batches of alcoholic liquor will require less time for acetification, and the process should be complete for each batch in three or four days. It is an advantage to add about one-quarter of completed acetic liquor to each batch of fresh alcoholic liquor, as the acid prevents the growth of obnoxious yeasts and bacteria, which live at the expense of the alcohol and acetic acid if allowed to accumulate in the apparatus.

The rate of production for each column should amount to about three gallons of acetic liquor every three or four days; at a conservative estimate half a gallon per day. This amount of liquor at 5 per cent content of acetic acid is sufficient to coagulate about 50 gallons of diluted *Hevea* latex, i.e. 160 to 200 sheets of rubber of 1 lb. each.

Experiments have been conducted by Mr. Thomas, of the Uganda Agricultural Department, using the acetic liquor made as above for rubber coagulation, with entirely satisfactory results.

(*Received for publication on 22nd November*, 1942)

A GEOGRAPHER'S RETROSPECT AND NOTE ON THE MPWAPWA LAND-USE EXPERIMENTS AND ACHIEVEMENTS

By C. Gillman, Tanganyika Territory

For years I have paid careful attention to the many progress reports on the Mpwapwa experiments by Messrs. H. E. Hornby and R. R. Stables which have formed so interesting a feature of the Tanganyika Territory Veterinary Department's Annual Reports; and I have visited Mpwapwa five time during the last nine years, the last occasion, in May, 1942, offering me an opportunity for gauging the achievements.

On my fourth inspection (as Water Consultant, in 1938) I summed up my interesting discussions with Hornby and Staples and the impressions gained in the field, thus:—

> ". . . . . Both these workers belong to that small group of men who use their specialist studies not as an end in themselves but as a tool for probing deeper and wider into the world, its problems and, if possible, its betterment. For my own hydrologic work these experiments are, of course, invaluable in many ways. Their chief value, however, I see in the direction of better land utilization and I am glad to find that these two workers, like myself, are suspicious of the fashionable efforts to turn the Bantu into a society of mixed farmers on small individual holdings, in a geographical environment which, with very few and isolated exceptions, for many reasons—chief among them the absence of properly distributed water supplies—simply will not, cannot, be made to fit into the scheme. We rather see in a suitable development of the savannah-engendered communal land tenure a better avenue for progress and a goal towards which the Mpwapwa experiments and ideas of bushland utilization appear to me most promising. . . . ."

And this year I was privileged to see and study the successful achievements of these high aims over an area that has extended greatly since my last visit. Under Hornby's masterly guidance I drove and walked many miles and many hours during four memorable days, to the constant accompaniment of most exhilarating, though at times strenuous, conversations and discussions: excursions, all of them, into wide vistas not only of a tectonically, morphologically and geographically fascinating corner of East Africa's great "shatter-belt", but also of the equally fascinating human problems connected with this environment and awaiting—crying for—solution. They took me over four distinct types of land, all representative of many, if not of all, conditions which dominate the semi-arid rain-shadow region of Ugogo:—

(*a*) The semi-arid outer southern pediments of the Kiboriani Block, waterless in the long dry season, with their deep colluvial (according to G. Milne) red soils under deciduous bushland (or "Baobab thorn", as I usually call it), partly still in its natural form, but mostly deteriorated into "debris after Man", to use Swynnerton's lucid term.

(*b*) The likewise semi-arid Kikombo valley and its "water-gap" outlet through the southern Kiboriani fore-block, where the marginal pediments with their, probably, mainly eluvial soils converge towards a narrow central strip of alluvium into which the drainage of the present cycle is cutting its as yet only incipient notches. Here the original vegetation, now largely replaced by artificial grassland, is also deciduous bushland with narrow fringes of meso- or hygrophytic forest along the few permanent watercourses that owe this permanency to their upland cradles on the more humid high block.

(*c*) The broader and flatter, mostly alluvial (?) valley of Buffalo Creek, descending from a fine cirque eaten into the southern flank of the east-central Kiboriani massif. This area is now likewise mostly experimental grassland, where the still visible remnants of the original vegetation indicate open *Acacia spirocarpa* woodland in the bottom, and semi-arid deciduous bushland on the margins and narrow pediments; with a conspicuous, locally developed and—to my mind at least—exposure-determined narrow *Combretum* belt, an outpost—or, better, an intermediary—of the *myombo* woodland which descends far down the south-east facing slopes of the high block. A charming valley framed by noble

mountains, where the present clearings afford an excellent opportunity for studying most convincing examples of the relations between *myombo* and exposure down to the minutest topographical detail.

(*d*) The very much wider, north-south trending depression of the middle Tambi and its northern tributary from the Mlali Gap, likewise under a sub-arid overhead climate; a broad stretch of predominantly alluvial land with its characteristic, more open *Acacia spirocarpa*—other *Acacia* spp. woodland as its original vegetation, and a denser fringe of *Acacia* forest along the main stream with a permanent groundwater flow. The in parts steeply sloping and often stony or rocky pediments carry, of course, deciduous bush. Here, too, the astonishingly and quite unexpectedly wide extent of the clearings provides fine vistas and interesting insights into the mountain land of north-western Usagara.

Thus, the only experimental area that I have not re-visited in 1942 is the one to the north of the Kiboriani Block with its "deferred grazing" successes, so well described in Staples' excellent little paper on "Combating Soil Erosion in the Central Province" (this *Journal*, January and April, 1942).

At this point I must also draw attention to the two interesting papers in the *Journal* for July, 1941, which are of fundamental importance to the comprehension of the aims and results of the Mpwapwa work: Staples' "Anti-Tsetse Clearing and Land Use" and Hornby's "Pasture Management in Relation to Tsetse Reclamation". They are complementary and should be read together, as Staples rightly lays great emphasis on water but omits the essential control of land exploitation, whereas this latter factor is well brought out as "an indispensable condition" by Hornby, who, on the other hand, refrains from dealing with the equally important water aspect of the problem.

Hydrology

The lysimeters installed in 1938/9 have started to "work" and although it may be premature to draw final conclusions from this early stage of the experiment, we can, I think, no longer doubt that, under the Mpwapwa conditions of climate and soil, clearing of the natural bushland on the pediments leads to a deeper penetration of much soil moisture which was formerly used up entirely in the life process of the plants. We have thus gained a fresh proof, under a new set of environmental conditions, for the usefulness of what I call "manipulation of vegetation" for creating new, or augmenting already existing, groundwater tables, if and where the geological conditions are favourable for the holding up of such tables by producing an impervious horizon at a suitable depth. These experiments are, therefore, a welcome addition to the arguments regarding the advisability of such manipulation which have been expounded in 1940 in several of my Water Consultant's Reports.

The experiments made with riverside clearing in the Kikombo Valley and at Matamondo seem to have established that sub-surface flow is maintained longer into the dry season and further down-stream in cleared than in uncleared watercourses; and that, thus far at least and under the particular conditions of run-off obtaining in the drainage basins of the streams experimented with, no appreciable damage has been done by high-water lateral erosion. We should not forget, however, that the time elapsed since clearing may not as yet be long enough to have led to the inevitable decay and ultimate disappearance of the original vegetation's roots which form such efficient protection against lateral scour; and we should, therefore, reserve our final judgment for a few more years, especially in the case of the Matomondo alluvial plain, where lateral erosion, should it set in, would quickly destroy the splendid artificial grassland evolved through the experiment.

Grass

John Phillips, of the University of the Witwatersrand, starts his 1941-2 Annual Report on the Soil Erosion and Grassland Improvement Work in the Union of South Africa with the following "Hymn on Grass" by John J. Ingalls:—

> "Grass is the forgiveness of Nature, her constant benediction. . . . Its tenacious fibres hold the earth in its place and prevent its soluble components from washing into the wasting sea. It invades the solitudes of the desert, climbs the inaccessible slopes and forbidden pinnacles of mountains, modifies climates, and determines the history, character and destiny of nations. Unobstructive and patient, it has immortal vigour and aggression. Banished from the thoroughfare and the field, it hides its time to return, and when vigilance is relaxed, or

the dynasty has perished, it silently resumes the throne from which it has been expelled, but which it never abdicates. It bears no blazonry of bloom to charm the senses with fragrance or splendour, but its homely hue is more enchanting than the lily or the rose. It yields no fruit in earth or air, and yet, should its harvest fail for a single year, famine would depopulate the world."

No doubt a fair, if somewhat highfalutin, statement which, on the whole, I think, one can safely endorse; but must one not take exception to the "silently resuming the throne" idea once the undeniable facts taught at Mpwapwa have impressed themselves on one's mind and outlook? For the outstanding fact, certainly in the environment of these experiments, is that grass, though comparatively easily established on newly cleared or on tilled ground, must be very carefully managed and husbanded to prevent a rapid re-occupation of the pasture by bush- or woodland.

To my mind the paramount result of these grassland experiments, proof for which stares one in the face on every plot, is the following: Grass must be looked upon and accepted by all those who wish—either voluntarily or under "pressure"—to make better use of East Africa's semi-arid lands as *an economic crop that requires effort and labour*; and that the best way to handle the situation is to *introduce a grass ley* into whatever rotation may prove desirable. On a fresh clearing or on agricultural plots ready to be rested a certain amount of *sowing*, depending on the degree of soil exhaustion by the crop and of deterioration by erosion, is inevitable as a rule; and suitable species of grass and their establishment and propagation have been the subject of prolonged study and experiment and are available for a variety of conditions.

This is the first point where the demand for labour, over and above that required for the usual native cultivation practices, enters the scheme of land improvement. The second and, really, the vital point is the maintenance of the new pastures which will generally consist largely of self-established grasses, and to a lesser extent of artificially introduced kinds. Without this maintenance the efforts of reclamation will be of no avail, as the slightest neglect will immediately result in a renewed onslaught of the forces of soil erosion, desiccation and general land deterioration. And the main task of maintenance is weeding, i.e. careful and continuous repression, through cutting down or, if necessary, stumping, of the bush- or woodland ever on the alert to re-invade its natural environment, certainly under East African conditions, where its behaviour does not seem to fit into Ingalls' pious hymn! This process of "weeding" naturally requires a good deal of unrelenting labour, but can be conspicuously aided by that much maligned fellow, the goat.* For to anyone studying the Mpwapwa experiments with an unprejudiced mind there can no longer be the slightest doubt that, while cattle grazing decreases the chances of grass in its competition with the re-invading bush, browsing by goats greatly increases them. The goat-plots, together with their cattle-grazed control plots, offer what would seem to be irrefutable evidence. This rehabilitation, or part-rehabilitation, of the goat does not, however, extend to other aspects, as, e.g. the protection against over-browsing of hill or mountain slopes under bushland, so essential for safeguarding the surrounding pediments against the devastations caused by excessive run-off, a policy for which the inselbergs of Usukuma and their recent successful closing to goats form so outstanding an example.

The so long misunderstood problem of grass *versus* bushland, a misunderstanding that has turned so much land into waste, not only by native activities but by those of white ranchers who have for long looked upon—and unfortunately are still looking upon—bush-grazing as a welcome addition to their pastures, is summed up laconically by Hornby, thus: "Bush- or woodland grazing inevitably leads—must lead—to ultimate land deterioration". For over-grazing of the bush is, of course, followed directly and very quickly by soil erosion of the worst type, such as the pediments around Dodoma, for instance, exhibit to perfection. But moderate grazing, too, inevitably results in a gradual replacement of grass by bush, followed by a rapid thickening of the latter to such an extent that grazing becomes no longer possible; and even if, as one might feel inclined to do, this thick bush is considered an eventual replenisher of soil fertility, the potential economic value of the land will never be what it was before grazing had started and when, with proper management, it could have been turned into permanently high-value pasture or arable land.

* These experiments were described in detail by Staples, Hornby and Mrs. Hornby in the October number of the *Journal* (pp. 62—70).

A most convincing argument in which I, for one, can detect no flaw.

And, finally, the establishment throughout a country whose geographical conditions point towards pastoral use, of such permanently valuable grazing lands would automatically and most efficiently deal with what Hornby so justly calls "the most serious disease of cattle: Starvation"; a truism at which a veterinarian can only arrive if he is also, and primarily, an ecologist, and thereby conceives the main duty of an African Veterinary Department to lie in the direction of fitting the cattle population into the country's general economics by an animal husbandry based on the best and safest possible use of the land.

Tsetse

The fundamentals for any plan or policy directed towards an optimum use of the land by a combination of agricultural and pastoral occupation plus forestry are, there can not be the slightest doubt, the regularizing of the hydrologic regime, the provision and maintenance of adequate and suitably sited water supplies, and the control of tsetse. I regard it, therefore, as a most fortunate hazard that our ecologically minded veterinary with his wide outlook was called upon to fill the vacancy in the directorship of the Tsetse Research Department three years ago; an appointment which gave the fullest and—one may say without flattery—a splendidly used chance to work forward in his great task of land-use studies. And thus we have to-day Hornby's sound dictum that *the only way to fight—or better to control—the fly is by correctly planned land use*. He also agrees with me, I believe, that where such land utilization is impossible (e.g. through lack of water), or undesirable (for tribal, administrative or other reasons, not to forget national parks!) a "tsetse problem" simply does not exist. In this connexion I may, perhaps, be permitted to quote what I said about the subject twenty years ago in an unpublished MS. on "The Tsetse Problem", at a time when our tsetse research was still in its prenatal stage, so to speak: "However much or little is known definitely about the life history and habits of the Glossinae, so much is certain that the fly depends (1) on certain types of vegetation, and (2) on the presence of game, cattle or man. The most efficient way, therefore, of combating the pest would seem to be one that removes both these essential environmental factors. This is undoubtedly done by close human settlement, whereby the bush is destroyed and the game driven away. In a few years, and with increasing density of population, the fly will have disappeared—and this without any cost to the Administration—and the settlers will be able to take to cattle breeding in addition to agriculture. . . . . Fly belts do not prevent settlement (purely agricultural in its beginnings) but settlement checks fly!". Hornby and I are likewise agreed that, as labour and money spent on correct land use automatically produces its own agricultural or pastoral reward, this method of controlling the fly is not only most efficient but actually costs nothing. All of this is, I need hardly say, not meant as an argument against research into the ecology, the natural history and the distribution of the tsetse fly, by which we have obtained, and are continuing to obtain—admittedly at considerable cost—much valuable fundamental insight without which the results of land-use experiments, such as those at Mpwapwa, would have been impossible.

Hornby's views on the whole question of tsetse control, so well supplemented by Staples, who deals more particularly with the agricultural aspect, have recently been published in the two papers mentioned in a previous paragraph. They need not, therefore, be repeated here at length, but it is desirable to pick out for the reader's guidance the following few items of outstanding importance: (1) The necessity for defining and maintaining very sharply the perimeter of a reclaimed area, "which should always stand as a wall of bush or forest separating open grass" (or agricultural land—C.G.) "from the surrounding fly-infested woodland". (2) The essential condition for planned reclamation is the introduction of, and strict adherence to, a policy securing "that subsequent utilization of the land shall be controlled judiciously by some authority." (3) There should be "little enthusiasm for barrier clearing", an opinion I fully share as I doubt the possibility of creating and maintaining economically really permanent and efficient barriers. And finally, this honest statement of the truth: (4) "If the threat of tsetse is necessary to inaugurate better methods of stock management, then this threat is a good thing".

Territorial Extension of the Mpwapwa Experiments

What has been so strikingly achieved and proved in the Mpwapwa area for one particular combination of the climate–topography–soil–water–vegetation–man complex must,

clearly, be repeated in as many as possible differing sets of dove-tailing environmental factors throughout the territory, in order to find out such modification in detail as the varying environment may demand. Of primary importance are, of course, those types of country which have in the past attracted closer settlement by pastoral Bantu communities, and those that form to-day potential land reserves. Among the latter the vast expanses of our *myombo* woodlands are of particular interest. To a certain degree the experience gained during the last fifteen years in the Medical Department's anti-sleeping-sickness concentrations in the Western Province and elsewhere will, no doubt, provide valuable basic material for an entirely different geographical environment. However, designed as they are primarily to eradicate a plague, these concentrations are, as far as I am aware, as yet not consciously concerned with the wider—or widest—aspects of proper land occupancy, are therefore at best incomplete attempts from the point of view of such occupancy, and urgently require further guidance in this direction by minds more fully equipped for the purpose. Another vast area of potential land reserves is found in the sedimentary rock-*myombo* woodland combination which covers so much of the Southern Province, where conditions differ markedly from those obtaining in the plateau-*myombo*, mainly because of the comparatively favourable distribution of permanent surface-water supplies. It is in these two regions where the Mpwapwa experiments should be repeated without delay by the men responsible for the work at Mpwapwa, or by similarly minded successors. I consider these steps of immediate urgency for the proper planning of native development in the territory.

Large-scale Application

Now, after we have been given this splendid lead by the master-minds of Mpwapwa, is the time to think of a large-scale application of the lessons learned throughout the country's native rural life; always, of course, with the proviso that the extension of the experiments advocated in the preceding paragraph goes hand in hand with such application. For, after all, and notwithstanding initial and not, I gather, very successful attempts to make the advantages of a controlled rural economy appeal to a small number of selected but somewhat disappointing squatters, the areas reclaimed at Mpwapwa primarily serve the requirements of the veterinary herds, have been created with paid labour, under most efficient expert supervision, and can, thus, by no stretch of the imagination be looked upon as even a small-scale application to tribal native life. (Incidentally, the one carefully laid out and nursed plot on which the panacea of the "ideal native small-holding" was to have been tested has proved, as I am told and as was to be expected, a complete and significant failure!)

However, advocating, pressing for, the commencement, at the earliest possible moment, of this large-scale application of the principles evolved towards an ever-improving native land economy, will remain mere pious and impotent hoping unless serious and definite action is taken beforehand for such readjustment of our native policy as will assure the control shown to be inevitable in a former paragraph. For it will serve no useful purpose if the Administration, in its mistaken attitude of *laissez faire* and *non possumus*, continues to blind itself to the brightly conceivable fact that, in order to achieve improved protection and utilization of land and water by the Mpwapwa methods, based on a combination of agricultural and pastoral husbandry with measures to combat fly and to preserve water, soil and forests, a relentless and annually repeated communal effort will be required from those we are anxious to aid and advance; not only for creating, but—more important still—for maintaining properly managed rural enterprise and settlement. If we do not, or think we cannot, in the peoples' very own interest, enforce (however "paternally") such communal effort, say by increased so-called "annual tribal turnouts" or other devices less unpalatable to the administrative mind, we had better stop paying lip-service to the "betterment of those entrusted to our selfless guardianship"! In the meantime one can only continue to hope that the prevailing administrative tergiversation may sooner or later, and perhaps helped by the lessons of the war and that "New Order" which, we are constantly told, will spring from them, make room for a more realistic and, in the long run, more humane attitude of mind and policy. If these conclusions should seem too aggressive to some of my readers I beg them to remember that we are passing through a period of world-wide aggression, probably unprecedented in the history of *Homo sapiens*, a state to which even a would-be saint cannot help succumbing occasionally.

(*Received for publication on 30th October*, 1942)

A PROGRAMME FOR THE CONTINUED PHOSPHATIC MANURING OF WHEATLANDS

By G. H. Gethin Jones, M.Sc., Soil Chemist, Department of Agriculture, Kenya

A comprehensive account of the phosphatic manuring of wheat in Kenya appeared in the October, 1941 (Vol. VII, p. 77), issue of the *East African Agricultural Journal*. This account dealt fully with the special requirements of different wheat soils; how superphosphate could suitably be wholly or largely replaced by the much cheaper forms such as Seychelles phosphatic guano or finely ground bonemeal and stressed the need for finely-ground materials and for strip applications in close contact with the seed. Amounts and mixtures of phosphatic fertilizers were suggested for different soil types, but only a brief reference was then made to later applications and the adoption of a programme for phosphatic manuring.

Suggestions on a programme of phosphatic manuring must be tentative only, as necessarily involved and long-range field experiments in the different districts have not yet been undertaken. Though it is necessary to adopt an approximation based on field work done elsewhere as to the optimum quantities or the rate of phosphate applications, recent local investigations do make it possible to advise on the comparative amounts of different kinds of fertilizers that are required to give about the same amounts of early-available phosphate.

The need for increased phosphate reserves

The greatly varying quantities of different materials of varying composition and fineness that are necessary to supply sufficient available phosphates in the current season have a marked bearing on a continued manuring programme. The larger initial dressing of less available materials makes possible smaller applications in subsequent years. In other words, the rate of application in later years may be progressively reduced more rapidly when Seychelles phosphate or bonemeal replace superphosphate.

Most of the local wheat soils are definitely low in reserves of phosphates and there is great need to replenish and build up the capital of phosphates so that the portion available each season is correspondingly increased. Wheat is known to require plenty of available phosphates in close vicinity to the roots during the early stages of growth. As the previous years' relatively small strip applications have become mixed throughout the surface soil by cultivation, there is need for continued annual strip applications to encourage intake by the young seedlings and, as the roots spread out, they can draw on the annually enriched mixed surface soil.

There now arises the question of the economic level of building up phosphate reserves. There is no danger of building up excess or harmful supplies of phosphates; it is really a question of the minimum amounts needed to produce economic returns commensurate with the capital which the farmer can invest in building up this reserve out of the total capital that has to be spread out to cover all production operations. It is necessary to estimate the minimum amount that should be spent on suitable phosphatic manuring so as to make the other farming operations more profitable. If funds are very low, then the farmer has to depend on small applications whenever wheat is sown so as to make good soil losses and prevent further reduction in yield. If at all possible, the farmer should aim at putting in rather more than is taken out, so that yields can be increased, while at the same time the reserves of phosphates are being built up and less will be required in the future. The amount needed to make good actual removal of phosphates in a grain crop is relatively small, but rather more must be put back to allow for losses in the straw, for reduction in availability of a portion of that added and for small losses of the richest surface soil by slight soil erosion. Excepting where surface erosion is severe, these losses can probably be made good by maintenance applications of the order of 20 lb. of phosphoric oxide per acre per crop of wheat. This amount can be put back into the land in the form of 1 cwt. of superphosphate or, better still, about 80 lb. of Seychelles phosphate or bonemeal. Where no manuring has been done, about these amounts have been removed off the land each year and this is partly the reason for diminishing yields. Therefore, in order to build up soil reserves of phosphates in new land low in this nutrient or in worn-out land, it is necessary to supply phosphate in excess of the natural losses. This illustrates how many farmers who have been giving small dressings for each crop have not been able to enrich the land in phosphates. It also shows the merit of using heavier dressings of the much cheaper forms or replacing much of the usual

superphosphate by these materials so as to hasten the building-up of reserve cheaply.

The minimum of phosphate reserve to be aimed at will naturally vary with the present fertility of the soil and also with the nature of the soil type. In the case of the red lateric loams, which have a great capacity for fixing added phosphate and holding this nutrient against rapid solution, it is necessary to build up more residual phosphate than in the case of the light-coloured and light-textured less acid soils which have a low capacity for tying up added phosphates. Suggestions for the reserves that have to be built up before the farmer can give smaller maintenance dressings are given below. These are based on the requirements of soils which are not appreciably eroded and which have not greatly fallen off in yield. In badly worn-out land, phosphates alone are not likely to do more than slightly raise the yield for a couple of years. As available materials vary in their phosphate content, it is necessary to quote the estimated additions to the soil reserves on the basis of essential nutrient (phosphoric oxide) per acre. Local Kenya wheat soils and their need for built-up reserves of phosphates may be classified in the following groups:—

(1) The red lateric loams of Kiambu, Subukia, Upper Gilgil, Ol' Kalou, Thompson's Falls, Kipkabus, Endebess, Nandi and Sotik: 200 lb. phosphoric oxide ($P_2 O_5$).

(2) The less reactive, highly-coloured soils such as the slightly pinkish red loams occurring in Timboroa and parts of Londiani; the shallow cinnamon-brown loams over murram common to the Plateau and Soy districts and to certain of the lower farms of Thomson's Falls and Ol'Kalou; the lighter-textured, reddish soils of Machakos, Hoey's Bridge and Trans Nzoia: 150 lb. phosphoric oxide.

(3) The reddish-brown and slightly cinnamon-brown loam of Upper Molo, Mau Summit, Kinangop, Ol'Joro Orok and Ol'Kalou; the greyish-fawn to greyish-brown silty loams to the south and east of Thomson's falls: 125 lb. phosphoric oxide.

(4) The Rift Valley light-coloured loams and light loams derived mainly from volcanic tuff and ash; the better dark-brown loams of the Ol'Bolassont Basin, Ol'Kalou and North Aberdares; the better, dark-brown loams of Burnt Forest, Endebess and elsewhere which have been cropped for many years without manuring: 100 lb. phosphoric oxide.

Apart from the obviously fertile soils, as shown by the high yields obtained in good seasons, most Kenya wheat soils are likely to give appreciably higher yields following manuring with phosphatic fertilizers. There is no danger of being extravagant in this respect if farmers aim at building up the relatively low reserves mentioned above for the different soil types. This suggested level of phosphatic manuring is much lower than that in common practice in temperate climates.

The building-up of phosphate reserves

We can now discuss the most suitable methods of building up these necessary additions so that the available portion is correspondingly increased. The past customary applications of 60 to 100 lb. of superphosphate per acre, with occasional heavier dressings of Seychelles phosphate, coupled with years when nothing was supplied, have not been helpful in building up reserves. In fact, the high cost per "unit value" of chemically prepared, water-soluble superphosphate, which has been the main form used in the past, made it uneconomical to rely on the reverted unused residues of heavier applications of this expensive material for this purpose. Now it has been shown that the much cheaper forms of bonemeal and Seychelles phosphate, if applied in relatively larger amounts, can supply sufficient available phosphates for the current crop and also leave behind much larger amounts of residue phosphate. These cheaper materials of higher phosphate content make possible an economical building up of reserves. If farmers had been giving heavier and about similar initial amounts according to the soil, it would have been possible to recommend simple progressive reductions in the strip applications as the increasing phosphate-status of the whole surface soil would supplement these annual dressings. One cannot advise a sequence of simple arithmetical reductions such as three-quarters, half and a third of the original amount, as this would mean that land which happened to have received the least would continue to receive the least proportionate dressings and the building up of the suggested reserves would become impossible. On the other hand, some wheat lands which may have had good phosphate applications in the past, including that given in farmyard manure or compost, may require no more building up, and in such cases small drill applications with each crop will now suffice to maintain this level against natural losses.

A more sound method of planning a programme of phosphatic manuring would be on the basis of continuing with the maximum which the farmer can afford with only a slight falling-off as the desired estimated reserve for the soil is approached. A fairly rapid method of investing this form of capital in the soil ensures higher yields earlier on and the change-over to smaller maintenance dressings whenever wheat is sown can be hastened.

This planned building-up of soil phosphates may be illustrated by the following example based on the Plateau cinnamon-brown loam over murram (second list of soil groups) where it is estimated that there is need to build up a minimum reserve of about 150 lb. per acre of phosphoric oxide:—

1940, no manuring; 1941, 100 lb. superphosphate containing 18 lb. (18 per cent) phosphoric oxide; 1942, 25 lb. superphosphate plus 175 lb. finely ground bonemeal containing 24 per cent phosphoric oxide. In three years this land has been given nil + 18 + 46 = 64 lb. phosphoric oxide. If the losses are put at the suggested value of 20 lb. phosphoric oxide per acre per crop, this means that hardly any reserves have been built up in this particular soil. There would be need to repeat the last-mentioned application or, failing there being any superphosphates, say 200 lb. of fine bonemeal or a mixture of fine bonemeal and Seychelles phosphate with an average phosphoric oxide content of 25 per cent for the years 1943, 1944 and 1945, followed by, say, 150 lb. of either, or mixture of these, for the following four years. Phosphate dressings would be given only when the land is cropped and any intermediate years under fallow or grazing would lengthen the building-up period. The resulting estimated gains and losses of pounds of phosphoric oxide are indicated as follows:—

$(50 \times 3) + (37 \times 4) - (20 \times 7) = 298 - 140 = 158.$

In practice, if superphosphate is obtainable and relatively cheaper, the dressings could be one part superphosphate mixed with 6 or 7 parts of finely ground bonemeal, or Seychelles phosphate according to the "unit value" cost of these two in the future. Having built up these extra soil reserves, which become distributed throughout the surface soil, the natural seasonal supply of available phosphates is increased and a small supplementary maintenance dressing of, say, 80 to 100 lb. of finely ground bonemeal, plus 20 lb. superphosphate, would suffice whenever wheat is sown. It is interesting to note the phosphate contribution made if it had been possible to apply even a single small dressing of only about 6 tons per acre of farmyard manure or compost containing 0.4 per cent of phosphoric oxide. This would have supplied 54 lb. of phosphoric oxide and would have saved 2 cwt. of bonemeal, or else the stage of giving the smaller maintenance dressing would have been reached three years earlier.

The above example seems to suggest a long-range programme, but in fact most farmers can calculate from several years back so as to include past applications of straight phosphates or that given in any bulky manures. It is noted how organic manuring lessens the need for purchased phosphates. Such small dressings as quoted above, if given every fourth crop, would probably supply about half the maintenance requirements of phosphates apart from improving the general fertility of the soil.

Following the building-up of reserves, maintenance dressings of phosphates—excluding that given in bulky manures or wood ashes, which may be deducted—may be suggested as follows:—Soils of group one, 100–120 lb. fine bonemeal per acre; soils of group two, 80–100 lb. fine bonemeal or Seychelles phosphate, or mixture, plus 20 lb. superphosphate; soils of group three, 80–100 lb. of fine bonemeal or Seychelles phosphate or mixture, plus 25 lb. superphosphate; and soils of group four, 60–80 lb. of fine bonemeal, plus 30 lb. superphosphate. In early-maturing areas of light-coloured soils within the fourth group, the mixture might be 60 lb. fine bonemeal, plus 40 lb. of superphosphate.

At present Seychelles phosphate and bonemeal are relatively cheap: finely ground bonemeal that is suitable for application to cereal crops is now available and is selling at a lower price per ton than at any time during the past decade. Relatively heavier phosphatic manuring now would give greater yields per acre when the urgent need for greater wheat production has ensured a higher price for this commodity.

In these notes special reference has been gvien to the phosphatic manuring of wheat. The enriching of arable lands in phosphate is also very essential for the formation of productive grass leys and would make easier a successful change over to rotational mixed farming when stock fed off the land and purchased feeding stuffs can help to maintain the enhanced soil fertility. The special emphasis given here to phosphatic manuring does not, of course, lessen the need for other sound farming methods.

(Received for Publication on 24th November, 1942)

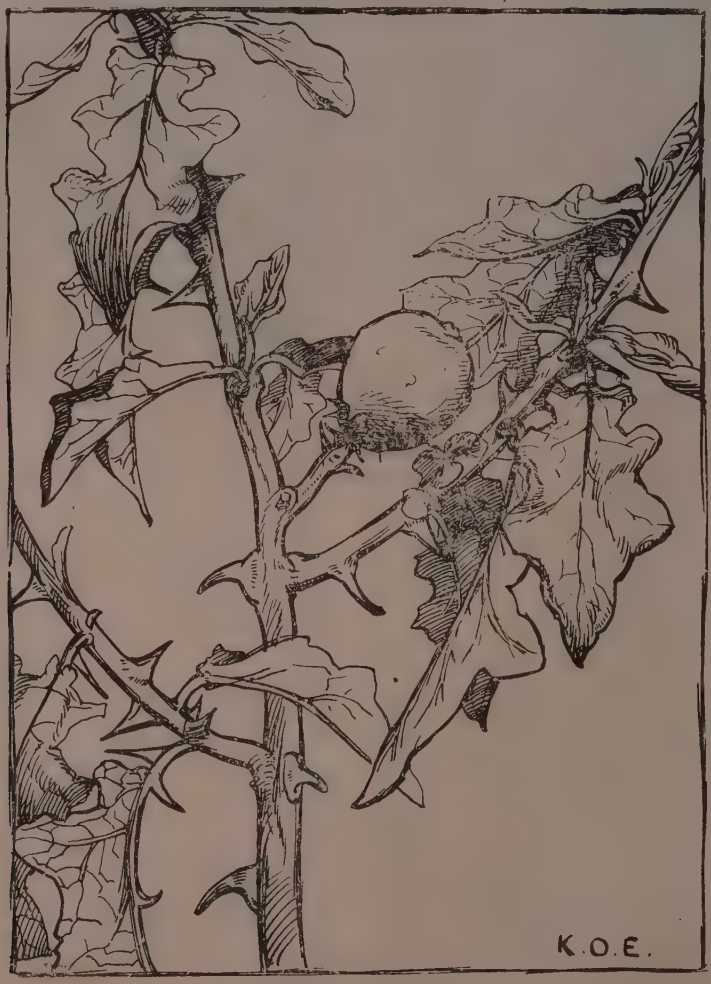
TWO USEFUL HEDGE PLANTS FOR HIGH COUNTRY

By L. A. Elmer, Assistant Agricultural Officer, Kenya

Owing to the chronic shortage of fencing wire, two shrubs indigenous to high country in Kenya are recommended to the notice of stock farmers at 7,000 ft. altitude and over. The shrubs can be grown by the side of existing fences to liberate wire in from two to four years, or hedges can now be planted to make paddocks in the future.

Both of these plants are found in the Kiambu Native Reserve from about 7,000 ft. altitude and upwards. *S. aculeastrum* also grows wild in the high country between Ainabkoi and Moiben. They may be more widely dispersed. The following is a brief layman's description:—

Solanum aculeastrum. — Kikuyu name, *Matura.* A fairly broad-leafed bushy shrub; grows up to 20 ft. in height. Flowers, like potato, but pale mauvy white, yellow centres, rather insignificant. Fruits large, round, green when young, changing to yellow on ripening; slightly warty or prickly. Stems and leaves thorny. Leaves green on top and almost white on the under-surface. (*See* illustration of spray.)



Solanum aculeastrum

Solanum marginatum L.f.—Kikuyu name, *Gatura*, but also called *Matura*. Similar to above, but with narrower leaves, and thinner, pointed fruits. Fewer thorns and leaves slightly darker green. This is possibly the better hedge-plant of the two.

Neither of these two plants should be confused with *Solanum campylacanthum* Hochst, the common Sodom Apple, a noxious weed with purple flowers and orange-coloured fruits.

Although both shrubs have been used by the Akikuyu for many years as hedge plants, the writer has only seen them in use by three Europeans, two having *S. aculeastrum* and the other *S. marginatum*. All are pleased with them, and further on in this article an extract from a letter on *S. marginatum* is printed.

From personal observations over several years, these two plants can be recommended for the following virtues:—

(*a*) The plants are easy to raise and to transplant.

(*b*) They grow quickly and under good conditions establish a strong hedge in from three to four years.

(*c*) Once well established they can stand the competition of bad weeds like couch grass.

(*d*) The growth is of a nature easy to trim and train, especially by natives, and cutting once or twice a year will keep them in good enough order.

In cool parts of East Africa, with a good rainfall, the plants would probably flourish down to 6,000 ft.

There is no established method of growing, and the following advice is offered merely as a guide.

Seed should be obtainable through any intelligent Mkikuyu from the high parts of the Kiambu Reserve around Uplands (Locations of Chiefs Makimei, Luka, Gathingo and Mwai). Settlers around Kipkabus can get seed from indigenous bushes. If difficulty should be experienced in obtaining seed, application should be made to the Department of Agriculture, Kenya.

The best time to collect the fruits is when they have turned or are turning from yellow to brown. The fruits are broken and the small flat brown seeds inside are washed clean and dried, or if the fruits are dry the seeds are merely shaken free or sifted free of the dry pulp and are ready to plant. Natives say that the seed can stand being scorched by fire, but this probably refers to the fruits. A degree of heat often helps hard seeds to germinate, e.g. the common practice of plunging wattle seed into boiling water and leaving it to steep. However, it is stated that the seed germinates freely in about fourteen days, so that no treatment is needed. A settler states that a native collected and cleaned about 4 lb. of seed in a week from an old hedge. A pound of good seed would probably produce 20,000 plants, but in practice an allowance of 1 lb. of seed per mile of hedge might be made until more is known about the germinating qualities.

Seed may be planted in situ or in the nursery. The nursery beds should be well drained and the seed be planted very thinly in drills 6 to 8 inches apart and about half an inch deep. It may also be scattered thinly over the beds and covered with half an inch of soil. When the seedlings are two inches high they should be thinned out to four or five inches apart; the thinnings can be transplanted into other beds. When eight to twelve inches high they are ready to be hardened off for two or three weeks before being planted out. It is useful to plant a number into banana-leaf pots or pot-shaped bags made of old sisal bag material. These will be left to grow under good conditions in the nursery, ready to fill up misses in the hedge line which may appear late in the season.

The line for the hedge should be ploughed or dug early, and as deeply and thoroughly as possible. The earth should be ploughed towards the centre or heaped in the centre so that the line when finished has the profile of a well-cambered road. The width cultivated depends on the danger apprehended from grass fires and whether the line can be weeded by hand entirely or partly by tractor or ox draft. Ordinarily 6 ft. wide is enough if it can be kept clean for three or four years, but if there is any danger of fire or of couch grass getting into the roots of the young plants quickly, then it will be wiser to increase the width up to 30 feet. When the hedge is well enough established to make weeding unnecessary it will be advisable to plant a grass like Kikuyu grass, which does not carry fire easily, as guard strips on each side. The mature plants can stand some scorching, but a bad fire should not be risked.

If the ploughing be done well a good bank can be established in three or four ploughings. The idea of this is to heap the fertile soil together and give a greater depth to encourage rapid growth as well as to leave a wide open furrow on each side to check the encroachment of couch grass. Where, however, the land

slopes, even gently, these open furrows are a danger, as they will collect storm water and lead to erosion; patches of the hedge may even be washed away.

Drains must be dug at intervals to take off storm water into the grass, and it may be necessary to take water from the higher to the lower side under the hedge by means of small culverts. These culverts should be at least 15 inches below the ground level and can be made of brick or stones. They should be made permanent on land where there are steep slopes above the hedge. If there is any doubt as to how to deal with storm water, application should be made to the Department of Agriculture for expert advice.

As a rule, once the hedge is established and a short firm sward of grass grows up to it, there is little danger of erosion, except where the conformation of the land is liable to cause storm water to sweep through the hedge. It is then that culverts are essential, for under a properly trained hedge, wide at the bottom, there will not be a tight grass sward but a rather loose friable soil, which can be washed away by a flood.

If the hedge is to cross a marshy place, a raised bank must be made, wide and high enough to allow the plants to grow in well drained soil. It is suggested that the top of the bank be at least 18 inches above the water table during the rains.

Large trees or bushes near the line should be removed, as they will cause weak growth and gaps in the hedge.

Poor patches of soil should be manured to make them equal to the average of the soil in the line. Bad anthills can have a trench dug through them after ploughing and the trenches can be filled with good top soil. The aim is to get even growth as well as quick growth.

It is best to complete all the preparatory work before the wet season starts. The seed can be planted and will be quite safe lying in the ground for a few days or weeks before the rains, and early planting will give the hedge a good start. Unless the soil is rich, manuring is recommended. A good way is to open a furrow along the middle of the line after the land has had its last harrowing. Manure is spread in the bottom and covered with a few inches of soil (a very light harrow will do this nicely), leaving a gentle depression along which a thin line of seed is scattered, covered about half an inch deep, and trodden firmly (but only if the soil be dry enough).

Sometimes cattle manure contains numerous weed seeds. If this is feared, compost should be made beforehand, as the heating to which it is subjected under proper manufacture will kill weed seeds in the manure which is used. Alternatively, bone meal, guano or wood ashes can be applied.

Particular mention is made of weed seeds, as unfamiliar seedlings may be lost by being weeded out amongst a mass of weeds which may come up after using cattle manure, especially that from squatter's stock. Some time ago, a big sample of *S. marginatum* sent out was lost by a native carefully weeding out the unfamiliar seedlings!

A sound method of planting designed to prevent such disasters is to put in a line of sticks at the ultimate spacing desired, which may be from three to five feet apart. The planting is done as follows: One boy goes ahead with a very wide hoe and scrapes a shallow depression about half an inch deep and one foot long, in one movement, on the same side of each stick. The planting boy follows with a tin of seed and from a distance of about two feet throws a pinch of seed into the place. This is to spread the seed and thus avoid getting weak seedlings growing close together. A third boy follows who pushes a little soil over the seed and treads the place. If the soil is in good condition and the line already marked out, a team of three boys using this method can plant two to three miles a day. When the seed germinates the weeding is done by an intelligent boy who just weeds each small patch and the rest of the land can be hoed by a gang.

When seed is planted out in the hedge line the young seedlings should be thinned out to about five inches apart when they are two inches high. When a suitable wet period arrives all misses are filled by transplanting from adjacent places. If the small plants are moved carefully they will not feel it and fall behind the others. The best way is to press the damp soil firmly around the seedlings to be moved and to dig them up with a bush knife or trowel, keeping the ball of earth intact. As the plants soon develop long tap roots, it is as well to do this operation when they are still under three to four inches in height, shading each one until it is growing again.

At 12 inches the young plants should be thinned out to their ultimate spacing in order to encourage sturdy growth and branching. If any late transplants lag behind they can be given a little bone meal or compost to help them to catch up.

It is most important to encourage a quick even growth and any very poor plants should be dug out and replaced by big plants raised in banana-leaf pots.

As the plants grow they should be kept very clean to encourage rapid growth. A hedge gets expensive if it has a bad start, grows very slowly, or is allowed to grow up with many weak patches. The whole art lies in making it grow quickly and evenly, and this can only be achieved by doing everything properly and at the right time.

If the line of cultivation is wide it may be possible to grow pyrethrum or other crops to help pay for the cost, but no plant should be nearer than three feet to the hedge plants and no bad weeds should be allowed to get established until the hedge is at least five feet wide and as high as required. This will take from two to four years, depending on the soil and climate.

The following letter from a man who grows *S. marginatum* is appropriate at this point. It will be noted that he plants out well-grown seedlings, and the plant is called *Matura* on his farm and not *Gatura* as around Uplands:—

"I certainly think *Matura* is the answer to no wire.

The one I use is that with pointed fruits; I prefer it to the other, but I might be made to change my mind on this.

I would advise ploughing or digging a four to five foot strip, then work in plenty of manure. I use a crowbar for planting, as the tap roots are long.

I have come to the conclusion that the best spacing is five feet. Closer planting has been unsatisfactory. The plants should be untouched until six feet high. Then break over as near the ground as possible by cutting half through the stem. The plants should all be pushed in *one direction only*. I do this about six weeks after the big rains have started and sometimes once more during the short rains, but once a year should be sufficient.

It just does *not* work to treat like a garden hedge and clip. It soon develops thin spots. It is best to have one boy with a stout forked pole pushing each stem over in one direction only, with another cutting at the base.

It is very important to push the hedge well down when breaking. I throw on billets of firewood or fence posts and remove after a few days.

Matura may be a short-lived plant compared with others, but it lives quite long enough to be very useful. I have never seen one die of old age yet, and we have some pretty old specimens here."

The other two settlers allow their hedges to grow naturally and cut them down once a year or less often.

It is suggested that the following method be tried: The plants, spaced at 4 to 5 feet, are allowed to grow naturally up to 3 feet, and then topped with a sharp knife to encourage branching. The hedge is topped again at 4 feet, which might well be the ultimate height. It is then trimmed to grow 2 to 3 feet wide at the top and from 6 to 10 feet wide at the bottom. Shears can be used or a short forked stake in conjunction with a sharp light *panga*. By this method no weak spots should develop.

If it is intended to cut the hedge regularly when established, it will be necessary to cut it once or twice a year. The plants will grow more slowly when cultivation ceases and couch or other grasses grow in amongst the roots.

A height of four feet is ample for stock. High hedges are expensive to keep in order.

Both these hedge plants can be allowed to grow away for some years without attention, as they are not very difficult or expensive to cut back. Neither of them is as difficult to manage as Kei Apple (*Doryalis caffra* Warb.) or Mauritius Thorn (*Caesalpinia sepiaria* Roxb.).

A common cause of gaps in hedges is natives and game pushing through when the hedge is young. It does not pay to block up gaps in a young hedge, otherwise the offenders make gaps elsewhere; the best plan is to wait until the hedge is big and then block the gaps thoroughly, if necessary putting on a patrol to arrest determined "gap-makers".

The great causes of failures with hedges in East Africa are fires and lack of attention. If the amount of organization and energy entailed by the construction of a wire fence were given to the establishment of a hedge, spread over the first few years of its life, the hedge could be as effective and cheaper. It has advantages over the wire fence, not only for the huntsman, but for the cattle, as it gives them shelter from the wind. Hedges, too, are a grand haven for birds, which play an important part in controlling insect pests.

(*Received for publication on 12th October*, 1942)

USING WOOL BY SIMPLE METHODS:
(1) WOOLLENS BY HAND

By George Rickard, Nakuru

Woollens and worsteds are the names given to all cloths produced from the fibres of the sheep's natural protective coat. There are many kinds of wool, and whilst all can be used for woollens, comparatively few are suitable for worsteds.

Woollens are produced by taking any mass of wool, carding it, teasing it out into a line of any given weight and spinning or twisting this line into yarn. Both short and long fibres may be used together. The yarn produced will be a criss-cross of interwoven fibre, which, when washed, will felt or mat together, and, if spun fine and tightly woven, will produce a cloth uneven in appearance but fairly waterproof.

Worsteds need long fibres which are combed until straight, laid together and spun. In appearance the cloth, when made, will be smooth, not matted, and easily becomes "shiny" when rubbed by wear.

Yarns for the manufacture of "woollens" may be easily produced by hand with simple appliances.

If a hard-wearing, undyed cloth is required, it is to advantage to leave a certain amount of the "olke" or natural grease in the wool. It makes for easy spinning and saves the later addition of "batching" or other oils.

The wool is washed in cold or luke-warm water to remove all dust and excreta. It is best to prepare a bath for this containing 1 lb. of soap and ½ lb. of alkali (soda ash), dissolved and worked in 10 gallons of water. The wool should be immersed, left for a time, then squeezed to expel the dirt. Avoid any stirring to prevent the wool matting or felting. A series of baths will bring the wool to the desired state of cleanliness.

I may say here that, if wool is to be dyed either before or after spinning, the whole of the natural grease must be removed during washing. At least three baths must be prepared and these all kept on the boil during the cleansing process. The success of the effect will depend on steeping or boiling, squeezing and the mixture of the bath. Too much alkali will brown and harden the wool. Immediately it is removed from the bath lay the wool out in thin batches in the shade to dry. Exposure to hot sun will harden and roughen the fibres, making a rather harsh feel to finished fabric.

If patterned material is planned in colour, dyeing is better after washing, making sure sufficient of one colour is put in to make the required yarn. You cannot easily repeat colour to shade.

On well washed wool dyes will "take" without difficulty. Dyeing by aniline colours presents no really troublesome factors, except, perhaps, level or evenness. Broadly speaking, the colour is put in the dye vessel, brought to the boil and the wool immersed. Boiling is continued for about an hour. Then the fixing salts are added and the boiling is continued for a further 15 minutes, after which the wool is removed for drying, again in the shade. With home-extracted dyes the procedure is the same, and from the grasses, mosses, trees, bushes and berries, all the delicate pastel shades so favoured for children's wear can be produced. During the boiling period keep prodding the wool, do not stir.

Having washed or dyed the wool, teasing or carding follows. In other words, prepare for spinning.

If the wool has been boiled and dyed it is necessary to spray with a mixture of soap and a fairly non-drying oil, such as neatsfoot, to enable spinning. One lb. of soap and one pint of oil to two gallons of water will do, and a pint of this well sprayed over 2 lb. of wool will be effective.

Wool washed in cold or lukewarm water cannot be effectively dyed and will not need spraying.

If hand cards are available put a small quantity of the prepared wool between and comb it well out. Pinch a few fibres out of the end of the roll, draw and twist into the required weight of yarn, making in this way about one foot of yarn. If hand cards are not available tease the wool well by hand and draw as before from a good-sized handful.

Spinning may be by simple spindle or wheel. This is fully described in my handbook, "Simple Spinning and Weaving" (obtainable from the Government Printer, Nairobi, price 50 cents).

Make fast the foot of yarn to the end of the spindle, spin and draw from the wool roll. The secret of good wool is to spin fine and even, although for woollens of tweed type unevenness is typical and may be disregarded to some extent. For knitting wools about six twists to one inch is ample and a very fine yarn is desirable. These may be doubled or "plyed" to any number required by twisting again

on a spindle or wheel. Yarns for tweeds are colour-mixed before carding. To the basic colour is added small quantities of different colour wools to blob or spot and are generally mixtures of greys, browns, with dots of purple, etc.

Weaving is difficult to describe without the assistance of numerous sketches, but in general a wooden frame is constructed of convenient size, say about 3 ft. by 2 ft. Yarns are stretched at ¼ inch intervals, up and down the length and called "warp". Under and over every one of these warp yarns, from side to side, is passed a yarn from a shuttle or ball, leaving each time a length of yarn called the "weft". This yarn is beaten down to the bottom or cloth end of the frame or loom. If each cross yarn is passed under alternate warp yarns cloth is formed.

More advanced frames or looms have rollers each end to enable long lengths of material to be made. As cloth is formed it is wound on to the bottom or cloth roller and more warp released from the top roller or warp beam. The actual work is kept near the cloth beam of the loom. About midway up the length of the loom string loops or "healds" are arranged to lift alternate yarns of the warp in sections to enable the shuttle to pass between the separated yarns or "shed" of warp. A simple mechanical device makes straight weaving very easy. Advanced looms contain a mechanical beater called a "sleigh", on which the shuttle runs and supporting a "reed", which keeps all yarns separate and ensures an even "beat up".

For all pattern weaving a series of "healds" is used, and likewise coloured yarns in groups are run through the warp, thus when these are overlaid by like coloured weft the pattern is left bold and distinct.

It is impossible in this brief article to go into detail of either of the foregoing, and for earnest students my handbooks are available, while for the more advanced, Pitmans' "Hand Loom Weaving" is suggested. There is undoubtedly scope in East Africa for the profitable and useful development of this home industry.

(2) HAND-SPINNING AND WEAVING IN EAST AFRICA

By Mrs. Rebecca Fane, Nairobi

In remote and isolated districts of Tanganyika and on the East African coast, the ancient crafts of spinning and weaving still linger, though up till a few years ago they had been forgotten—if they had ever been heard of—over the greater part of the East African territories. The coming of the European did not serve to spread them, for though they were taught in a few schools, these crafts did not become popular, while at every trading centre the African could buy the clothing and blankets which were within his financial means. (The immigrant Indians brought the crafts—to them traditional—with them, but did not practise them for obvious reasons.) Later attempts made by the Administration and by settlers to make spinning and weaving a part of African life looked promising at first, but met with no permanent success. The incentives were lacking, and were not forthcoming until this war severely restricted imports: to-day a scarcity which is almost a famine, coupled with the high prices of any knitting yarn or woollen goods available, have convinced the inhabitants of East Africa, of all races, that if they want these things they must provide them for themselves.

They are confronted with no light task. In 1939, the last year of normal importing, 19,365 blankets, 41,479 yards of tissues, 7,639 lb. of yarns, and 31,420 dozen pairs of wool and cotton hosiery were imported into East Africa. But that is not the sum of what is required to-day. The civilian population has increased considerably, the military population is not negligible, we have more than a few prisoners of war, and to swell the total there has recently been an influx of Polish refugees. There is a textile factory, it is true, at Nakuru, which meets part of the military demand, but it cannot do more than that, and the establishment of further factories is fraught with difficulties. Hand-spinning and weaving therefore must be looked to for supplying the deficiencies. Fortunately, the breeds of sheep raised on European farms in Kenya, the Corriedale, the Romney Marsh, and the Merino, all grow a fleece which is suitable for hand-processing.

There were—and are—several difficulties to be overcome before the industries can be said to be firmly established. First, the supply of suitable fleeces must be assured. Although there is an ample supply of raw wool of the right types, not all of it lends itself to hand-processing. Sometimes its staple is too short, sometimes the wool is too dirty, but it is hoped that as the demand for longer-stapled cleaner wool grows, the supply will keep step with it. Next comes the supply of appliances.

There are two indispensable processes in spinning—teasing, or "carding" the fleece, and the actual twisting of it into yarn by means of either the simple "spindle" (a rod slightly thicker than a thick knitting needle, with its point piercing the centre of a wooden disc (the "whorl") about 2½ in. in diameter) or by a spinning wheel. The correct appliances for preparing the wool are "carders"—brushes whose bristles are made of a fine gauge spring-steel wire, set in leather, with wooden backs. There were less than a dozen pairs of carders in the country when hand-spinning was started—and there are no more now, though it is hoped that a hundred pairs are on their way from England. In the meantime, ordinary combs and the human fingers have proved to be useful substitutes. In the manufacture of spindles, no difficulty arises, as little material or labour goes to their production, and hundreds are now in action. To start and keep up a steady flow of spinning-wheels is a less simple matter. A number of wheels came to light in the homes of settlers; these were pressed into service as models and the K.U.R. & H. undertook to manufacture a limited number of reproductions in their workshops. The next need to be met was for instructors. In this East Africa was lucky. From among the settlers and the staffs of schools women came forward who at some earlier date had learnt to spin and weave; several of them were experts, and all were ready to help. First spindling, and then spinning on a wheel, were taught by these enthusiasts; soon some of the pupils themselves became instructors, and so knowledge of the craft quickly spread. Weaving was the next task to be undertaken. Looms abandoned in earlier experiments were reconditioned, new looms were made, and already in several districts weaving has started.

In the early days of their recent revival, the hand-spinning and weaving industries were assisted by an informal committee. Their expansion soon became so great that the collection and distribution of raw material and appliances, the organization of instruction and the distribution of information became tasks demanding—and deserving—Government support. They obtained it, in the form of an "East African Spinning and Weaving Committee", set up under the Industrial Research and Development, with secretary, central offices and a room for classes and exhibits, in Sadler Street, Nairobi (P.O. Box 991).

It is hoped that all over East Africa subsidiary centres will spring up to serve their own districts and give impetus to the "production drive" for hand-spun and woven textiles, and to prove how valuable a part of rural life the practice of these hand-crafts can be—valuable not only at the present moment, but in the days to come. That they are financially profitable to-day can be seen from the following figures. The present price of imported woollen yarn—on the rare occasions when it is obtainable—is Sh. 24 a pound. The price of the raw material (fleece) is 80 cents to Sh. 1/25 a pound. In carding and washing it, over half its weight is lost, therefore the cost price can then be said to be not more than Sh. 2/60 a pound. Add a few cents for the cost of the soap for washing the yarn, and for not more than Sh. 2/70, plus the cost of labour, you can have (if the spinner is skilled) a pound of woollen yarn as fine and as soft as the best Shetland. A good spinner on a wheel will produce as much as 20 lb. of yarn (if she starts with it already carded) in a month, so it can be seen that the margin of profit is a generous one. And it should not be overlooked, when hand-spinning and weaving by Africans is under discussion, that these crafts can well be part-time occupations for them; the boy can spin while he is herding, and men and women can spin while they are gossiping over the cooking fires at night—even while they walk to the market or to visit their friends.

There are as yet no figures which give the costs and profits for hand-woven materials, but the growing shortage of machine-made textiles assures a good market for the hand-woven equivalent. And a craft which has been able to survive even in highly industrialized countries like Britain should surely be able to hold its own in East Africa, even when the present abnormal conditions cease to exist.

An aspect of the subject which has not yet been touched on in these notes should also not be overlooked—and that is the value of these crafts for their own sakes. The good spinner is a skilled craftsman, but the weaver can be an artist also, for he has wide scope for the exercise of his sense of colour and design. The Middle Ages in Europe have often been sentimentally overpraised, but even their detractors would admit that the people who lived then had one advantage denied to us who live in the machine age—the opportunity to make every craft an art, and to make the things used in daily life not only useful but beautiful. It would be much to the credit of British administration if it pointed Africans along the same road.

A METHOD OF HANDLING TRAYS IN AINABKOI PYRETHRUM DRIERS

By Gilbert Walker, Dawani

In No. 6 of Vol. V of the Journal there was published an article by the writer describing a semi-automatic method of removing, when its flowers were dry, the lowest tray in the Ainabkoi-type pyrethrum drier, in order to save the considerable labour of taking out each tray of the stack individually by hand and replacing it in a lower position, or, in the case of the "Colquhoun" arrangement, of one attendant having to go round to the back of the drier to raise and lower the far end of the stack of trays.

The method involved a rather special kind of tray with one end of the side cut on the slant.

Since then another system has been used, and as the trays can be made more simply and are reversible end for end, it is an improvement and its description may be of interest.

The trays are made the usual three feet wide and as long as desired (eight feet is a convenient length). The frame is of 3 in. by 1½ in. timber, the wire mesh is fastened beneath it by ¾ in. by 1½ in. slats nailed on the underside. The side members project 3 in. or 4 in. at each end, forming handles, and these are cut away slightly on the underside to allow a space of 1½ in. between the upper face of one handle and the lower face of the next one above it when trays are stacked one on top of the other in the drier.

The lifting of the pile of trays lying on the lowest tray is done by ¾ in. iron rods a little longer than the width of the tray, resting horizontally, one at the front and one at the back in the 1½ in. space between the handles.

The rods are raised by small wire rope or chain fastened near each end of the rods. The ropes of the front end are fastened to a horizontal roller fixed vertically above, and clear of, the pile of trays; those of the back rods first pass over wooden pulleys similarly fixed above the pile and are then brought forward horizontally and fastened to the same roller.

The roller is worked by simple small windlass handles or by a lever. In order to raise the pile of trays lying on the top of the bottom tray when the latter is ready to be removed or inspected, the rod at the front end, which normally lies beneath the handles of this tray, is moved by hand into the next space above, so that it is now on the top of the handles of the lowest tray, ready, when the windlass is worked, to raise the front end of the stack.

By means of a simple device, which is more easily sketched than described, the rod at the back end is, by pulling a cord, pushed backwards by a sliding bent piece of round iron (an old lorry brake-rod will do for this), moved by an arm on a pin until it is clear of the ends of the handles above it. The cord, which works against a small spring, can be held or hooked on to a nail while the windlass is being turned. When it is seen that the slack in the wire rope on the front rod is taken up, the cord is released, for the back rod has now risen clear of the ends of the handles, and by its own weight has swung forward again into the space above them, so it is now in the same relative position as the front rod, and a further turn of the windlass will lift the stack of trays the couple or so of inches required to enable the lowest tray to be drawn out. The windlass can be kept in position as long as necessary by sliding along a wooden stop to catch against it. When the dry tray has been taken out the windlass is released and the stack lowered, a new tray being put in at the top.

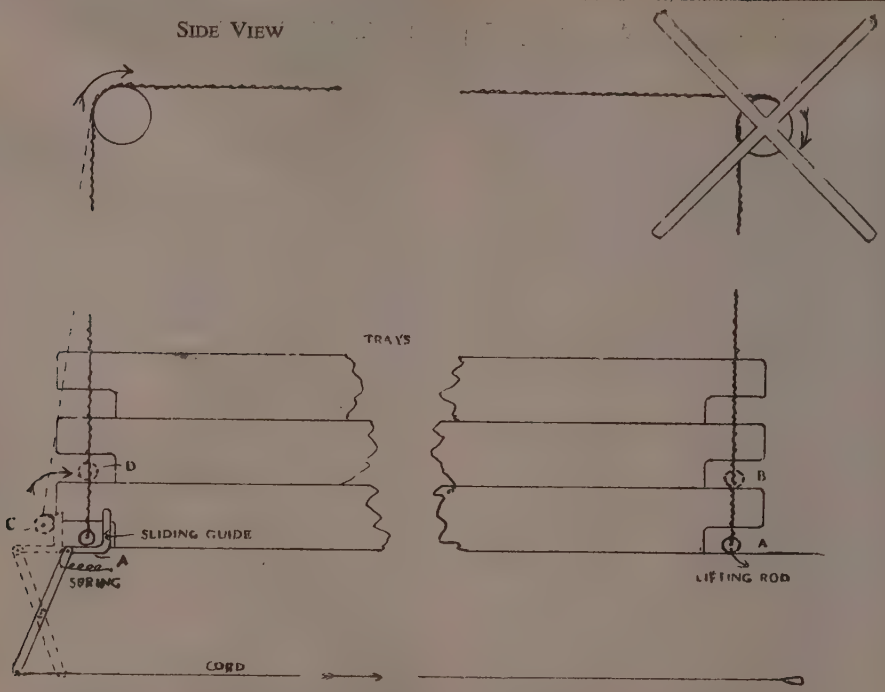
A wooden roller, 2 in. or 3 in. in diameter, or bit of piping with windlass handles fixed on to it, can be used for the two outside bays of the drier. With the middle bays, where there is not so much room to spare, a larger diameter is better, so that half a turn with a lever will do all the raising that is needed. The rollers can work in wooden bearings. Thin wire rope can often be got by unravelling a piece of old rope of larger size, but it will be seen that very little of it is really required, for, except where it goes over the pulleys and rollers, ordinary wire can be used.

Instead of using the cord and sliding guide device, the back rod can be pushed clear of the tray handles by a thing like a hay rake with only two teeth upside down, worked forwards and backwards with its handle through suitable slots from the front.

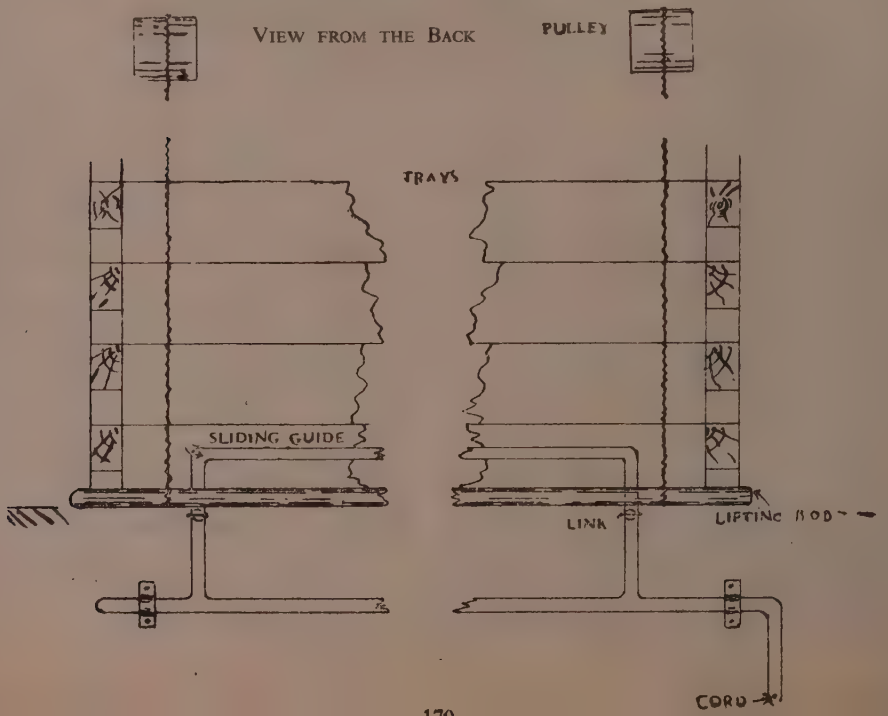
The whole of the back of the bays can be closed up and all of the front except for spaces at top and bottom wide enough for putting in and taking out a tray. These spaces are closed with shutters.

The arrangement works well and smoothly, and is inexpensive to make.

(Received for publication on 7th September, 1942)



A—Normal position of lifting rods. B—Front rod placed ready for lifting. C—Back rod pushed clear of tray handles by the guide by a pull on cord. D—Back rod has been raised by winding and has swung back to lifting position.



EMERGENCY DIPS FOR CATTLE TICKS

By E. Aneurin Lewis, B.Sc. (Agric.), M.Sc., Ph.D., Veterinary Research Laboratory, Kabete, Kenya Colony

The active ingredient of arsenical cattle dips used for the destruction of ticks is arsenious oxide or, as it is more commonly termed, white arsenic. In the raw or the pure state it is only slightly soluble in water; but when combined with caustic soda or with carbonate of soda to form sodium arsenite it can readily be dissolved.

In peace time, sodium arsenite and other brands of dips widely used in East Africa are imported as manufactured products. In time of war, the importation of these ready-made and proprietary dips may be irregular; and supplies may at times be insufficient to meet local demands. Certain precautions have already been taken to enable farmers to continue with the practice of regular dipping; and investigations have been made to ensure supplies of dipping material even in cases of extreme emergency. Arsenious oxide is produced in the Rhodesias; carbonates of soda are obtainable in Kenya; and caustic soda can be manufactured from soda ash or other carbonates and lime. Sodium arsenite can, therefore, be prepared locally either as a concentrated stock solution or in small quantities sufficient only for the farmers' immediate and urgent requirements.

Home-made arsenical dips are recommended and widely used, with success, in the United States of America, and in Australia. Two methods of preparation are contained in a bulletin issued in 1932 by the United States Department of Agriculture. The ingredients and quantities are:—

Dip No. 1	
Arsenious oxide	10 lb.
Caustic soda	4 ,,
Sal-soda crystals	10 ,,
Water	5 gallons

Dip No. 2	
Arsenious oxide	8 lb.
Sal-soda crystals	24 ,,
Water	25 gallons

The first, containing caustic soda, is known as the "self-boiled" or S-B dip because sufficient heat to prepare the dip is usually generated by chemical action between the raw materials. The second is called the boiled dip because it is necessary to heat the water to boiling point before adding the soda and again after adding the arsenious oxide.

Pine tar is added to the diluted bath, or sometimes to the concentrated boiled dip solution, in order to increase the wetting and spreading properties of the dip, and to improve its effectiveness against ticks. Pine tar is not readily obtainable in East Africa; and as many farmers have had satisfactory—not necessarily the best—results with a plain water solution of sodium arsenite, the pine tar may, under the circumstances, be omitted. For the same reasons, the Stockholm tar, the oils, and potash soap incorporated in the Australian formulæ may be omitted for the time being; but if this is done, then the New South Wales formulæ should be adjusted to contain an excess of the alkali to ensure complete conversion of the arsenious oxide into arsenite.

The caustic soda content of the Australian formulæ varies considerably, and it is felt that to reproduce those formulæ at present would merely confuse the local farmers who might wish to prepare their own dip from the raw materials obtainable in East Africa. The American methods are more simple and more easily adaptable. The Sal-soda (crystals of carbonate of soda) must be replaced by the powdered and more concentrated soda ash produced locally. For this purpose, and allowing for impurities in the local products, it may be taken that 4 lb. of dry, powdery soda ash is equivalent to 10 lb. of Sal-soda.

The American formulæ given above should, therefore, be modified to:—

Dip No. 1	
Arsenious oxide	10 lb.
Caustic soda	4 ,,
Soda ash	4 ,,
Water	5 gallons

Dip No. 2	
Arsenious oxide	8 lb.
Soda ash	10 ,,
Water	25 gallons

Soda ash is reputed to be of uncertain strength when purchased; it tends to become weaker on exposure to air, while in contact with water it lumps and dissolves rather slowly. Experiments in the laboratory, however, indicate that, with care, this form of carbonate produces satisfactory results bearing in mind that no other essential ingredients, or means of replenishing the dip, are available.

Directions for No. 1 Dip

To prepare the S-B stock solution use a metal container of 5 to 8 gallons capacity. The chemicals in this solution corrode zinc, tin and solder, but have no effect on iron.

The materials should be ready to hand before starting; and there should be some means for heating the solution in case the heat created by mixing the materials should be insufficient to dissolve all the arsenious oxide. A small portable charcoal burner might be most convenient.

Put all the caustic soda into the container, and add one gallon of water. Stir with a stick until the caustic soda is dissolved. A considerable amount of heat will be generated. Add the arsenious oxide, a pound or two at a time, without splashing, stirring all the time. If the liquid begins to boil, allow to cool slightly before adding more arsenious oxide, and stop stirring. The liquid should be hot but not boiling. When all the arsenic has been added, the liquid should be clear except for dirt from perhaps the impure materials. If it is slightly milky, the operation has been carried out so fast that much of the water has been boiled off, and the sodium arsenite has begun to crystallize: So add another gallon of water, and stir again. If the solution does not then clear up, the caustic soda must have been of a very low grade; and the undissolved substance, usually in the form of whitish grains or powder, contains arsenic. In such a case put the container over a fire, heat to nearly boiling point, and stir. As soon as the arsenic is all dissolved, dilute to four gallons, add the soda ash, and stir until that is dissolved. Add the soda ash while the liquid is hot, but not boiling. After cooling, add more water to make exactly five gallons.

The operation should be carried out in a well ventilated place; and the operators should keep their heads well away from the steam and fumes rising from the hot liquid.

If the stock solution is not to be used immediately, transfer to a suitable container which can be stoppered tightly. Label it with large and clear letters "S-B Dip—POISON"; and store under lock and key. It is assumed that all precautions will always be taken to avoid spilling the concentrate, the arsenious oxide and the caustic soda where they may be accessible to stock or cause injury to human beings.

Dilutions for the Dipping Tank

The dipping tank should contain a known quantity of water. If a dip of three days' strength (0.08 per cent arsenious oxide) is desired, add four gallons of the stock to every 1,000 gallons of water. For a dip of five to seven days' strength (0.16 arsenious oxide) eight gallons of the stock should be added to every 1,000 gallons of water; and for a dip of 10 to 14 days' strength (0.24 per cent arsenious oxide) 12 gallons of the stock will be required for each 1,000 gallons of water.

Pour the stock in a thin stream on the surface of the water in the deep section of the tank; and stir well. The dip should be tested before the cattle are passed through. For this purpose the Kenya Field Dip Tester and Cooper's Dip Test outfit are suitable, and to enable farmers to estimate the strength of the dip with these outfits, instructions for testing any kind of arsenical dip will be issued in the near future.

Replenishing the Dip

When all the cattle have been dipped, or before the next dipping, water is run into the tank to replace the liquid taken out in the hairy coats of the cattle and that lost by evaporation and leakage. The tank may, of course, have been filled and flooded by rainwater. The quantity of fluid in the tank must be ascertained; and the strength of the dip determined. The percentage of arsenic may be above or below the required strength. In a 3-day dip, it should never be below 0.08 per cent estimated as arsenious oxide, as this is considered, for practical purposes, to be the minimum concentration for the destruction of ticks. With the stronger dip (5–7 days, and 10–14 days), a small margin of error is permissible, and often overlooked, in practice. Nevertheless, farmers should endeavour to adhere to the strengths recommended. An error greater than 5 per cent above or below strength in the case of a 3-day dip, or greater than 10 per cent in the stronger dips, should always be corrected by adding water or concentrated stock solution of arsenic.

Table 1 shows the quantity of concentrated S-B solution required (second column) for every 1,000 gallons in the tank when a 3-day dip is below strength. It also gives the amounts of arsenious oxide, caustic soda, soda ash and water (in the third, fourth, fifth and sixth columns respectively) that would be required to make up the concentrate, if the stock solution has not already been prepared.

The quantities for a 5 to 7-day and for a 10 to 14-day dip can be obtained by multiplying the figures given in Table 1 by 2 for the former dip and by 3 for the latter.

As an example:—Assume that a 5 to 7-day dip is 10 per cent (−10) below strength. Reference to Table 1 shows that when the "percentage error" (first column) is −10, the quantity

TABLE 1
Three-day Arsenical Dip (0·08 per cent)
S-B stock or raw materials for each 1,000 gallons of dip

Percentage error	Stock to be added	Amount of white arsenic	Caustic soda required	Soda ash required	Water
Per cent	*Pints*	*Ounces*	*Ounces*	*Ounces*	*Pints*
—50	16	64	25½	25½	16
—45	14½	57½	23	23	14½
—40	13	51	20½	20½	13
—35	11¼	45	18	18	11¼
—30	9¾	38½	15½	15½	9¾
—25	8	32	13	13	8
—20	6½	25½	10½	10½	6½
—15	5	19	8	8	5
—10	3¼	13	5	5	3¼
— 5	1⅝	6½	2½	2½	1⅝

of "stock to be added" (second column) for a 3-day dip is 3¼ pints for every 1,000 gallons of liquid already in the tank. Or this quantity (3¼ pints) of concentrate can be prepared from 13 ounces of white arsenic, 5 ounces of caustic soda, 5 ounces of soda ash, and 3¼ pints of water. These figures must be multiplied by 2 to obtain the correct amounts for a 5 to 7-day dip. Thus 6½ pints of the concentrate are required for every 1,000 gallons of a 5 to 7-day dip which is 10 per cent below strength; and the materials for making up this quantity are 26 ounces of white arsenic, 10 ounces of caustic soda, 10 ounces of soda ash, and 6½ pints of water.

If the dip is above strength, Table 2 shows the quantity of water that should be added. This table serves for all strengths of dipping fluid. For instance, if a 3-day dip is 15 per cent (+15) over strength, add 150 gallons of water to every 1,000 gallons of dip. If a 5 to 7-day or 10 to 14-day dip is 15 per cent over strength, add the same quantity of water.

TABLE 2
Quantities of water required, for every 1,000 gallons, to correct dips Nos. 1 and 2 at three, five to seven and ten to fourteen days' strengths

Percentage error	Gallons of water required
Per cent	
+ 5	50
+10	100
+15	150
+20	200
+25	250
+30	300
+35	350
+40	400
+45	450
+50	500

DIRECTIONS FOR NO. 2 DIP

A container of over 25 gallons capacity is required for the preparation of this boiled dip, which is less concentrated than the S-B stock solution. A 40-gallon drum may be most convenient; it should be clean and free from grease or oil that would prevent the particles of arsenic from entering the solution.

Pour 25 gallons of water into the drum, heat to boiling, and add the 10 lb. of soda ash. If the soda is lumpy, it should be broken up with a stout stick and stirred vigorously until it is all dissolved. Add the 8 lb. of arsenious oxide, heat again to boiling point, and stir until the arsenic has disappeared. Allow the solution to cool, make up to 25 gallons by adding water, transfer to well-stoppered containers and store. Label as "Boiled dip stock" or "Stock No. 2 dip"—POISON.

This concentrated solution is not corrosive as in the case of the S-B stock solution.

DILUTIONS FOR THE DIPPING TANK

Fill the tank with water up to the dipping line, and ascertain the quantity. To every 1,000 gallons of water add the following quantities of stock solution (No. 2 dip):—

For 3-day strength, 25 gallons of stock solution.

For 5–7 day strength, 50 gallons of stock solution.

For 10–14 day strength, 75 gallons of stock solution.

After adding the stock solution, stir the liquid in the tank thoroughly. This should be done before every dipping operation and before testing for arsenic because a solution of arsenic is heavier than water, and it tends to settle below the surface of the dip and with the mud and dirt accumulated at the bottom of the tank.

TABLE 3
Three-day arsenical dip (0·08 per cent) Boiled stock or raw materials for each 1,000 gallons of dip

Percentage error	Stock to be added	Amount of white arsenic required	Soda ash required	Water
Per cent	*Pints*	*Ounces*	*Ounces*	*Pints*
—50	100	64	80	100
—45	90	57½	72	90
—40	80	51½	64	80
—35	70	44¾	56	70
—30	60	38½	48	60
—25	50	32	40	50
—20	40	25½	32	40
—15	30	19¼	24	30
—10	20	12¾	16	20
— 5	10	6½	8	10

REPLENISHING THE DIP

Before dipping, re-fill the tank with water up to a given line at which the quantity of liquid is known. Test the dip as before and determine the percentage of error, if any. Refer to Table 3, which gives the quantity of stock solution, or the materials, required for every 1,000 gallons of dip when below strength. These figures apply to a dip of 3-day strength, and must be multiplied by 2 for a 5 to 7-day dip, and by 3 for a 10 to 14-day strength. If the dip is over-strength, reference to Table 2 will show the quantity of water to be added in every case.

THE CAROTENE AND VITAMIN A VALUES OF COLOSTRUM FROM HIGH-GRADE COWS

By M. H. French, M.A., Ph.D., Dip. Agric. (Cantab.)
(Mpwapa, Tanganyika Territory)

Whilst investigating some of the reasons for the constitutional failure of pure-bred and high-grade Ayrshire cattle at Mpwapwa, it was considered of interest to determine if the young calves were able to obtain from their dams adequate supplies of carotene and vitamin A. As is well known, the liver reserves of vitamin A are very small at birth, and it is essential that young calves should receive large quantities of this vitamin or its precursors as soon as possible after birth. Colostrum is the normal channel by which large supplies are transferred from the dam to her offspring and this article records the values found for the colostrum of four high-grade and one pure-bred Ayrshire. The figures obtained are then compared with similar findings in Scotland to see if the locally born high-grade calf is at a disadvantage in its early days when compared with pure-bred calves born in a temperate zone.

It has been shown by Dann (*Biochem J.* 27 (1933), 1998) that Shorthorn cows produce colostrum containing many times the amount of carotene and vitamin A found in their normal milk. A number of later workers have shown that the amounts of these constituents in butterfat vary with the breed of cows examined. Stewart and McCallum (*J. Agric. Sci.* 28 (1938), 428) have, however, reported upon the carotene and vitamin A values recorded for 100 Ayrshire cows in Scotland, and so a direct comparison can be made with their results.

The first sample examined from each cow was collected within a few hours of calving, whilst the subsequent samples were taken from the normal morning and evening milkings.

The vitamin A contents were estimated by means of the antimony trichloride technique, after separation by the alkali-digestion method of Davis (*Biochem. J.* 27 (1933) 1770). The blue colour was measured in a Lovibond tintometer. Whilst this method of separation is open to criticism, it was chosen because the Scottish figures were also obtained by this method and a more direct comparison could consequently be made. The carotene contents were measured by matching the yellow colour of the chloroform solution of the unsaponifiable matter in the tintometer, because there is little evidence that pigments other than B-carotene are present in significant amounts in butterfat from cow's milk.

The results were recorded during 1937 dry season and the follwing notes are of interest:—

Pure-bred heifer 261 calved on 19th May, 1937, whilst there was still a certain amount of green grass available. The ¾-grade cow 23 calved on 21st June, 1937, when the quantity of green grass was very much less, but she was receiving 5–7 lb. maize silage daily. Heifers 265 and 266 calved on 27th June, 1937, and 5th July, 1937, respectively, and were fed in the same way as cow 23. Heifer 278 calved on 11th August, 1937, and by then the available green grass was practically nil, though maize silage was fed at the above rate.

In all cases a considerable fall takes place in the carotene and vitamin A contents from the first day's samples as the character of the colostrum approaches nearer that of milk. There is also considerable variation between different animals in the levels of carotene and vitamin A on the first day after calving, and high carotene content does not necessarily accompany a high level of vitamin A. These observations are exactly as recorded by Stewart and McCallum for Ayrshire cows in Scotland. The Mpwapwa range of values are within the limits found by these workers, and so the colostrum of high grade and pure-bred Ayrshires at Mpwapwa can be regarded as having normal carotene and vitamin A values.

The Mpwapwa custom of feeding maize silage during the dry season, when green grazings are scarce or non-existent, therefore allows the carotene and vitamin A values of colostrum to remain within the normal range. High-grade calves, even in the dry season, obviously get a good supply of these essential food accessories from their dams, though it is probable that the quantity of colostrum available is smaller than that yielded in the British Isles. In these studies, the pure-bred heifer reached a yield of one gallon daily on the fourth day after calving, whilst the highest yield was given by ¾-grade heifer 278, who reached 1¾ gallons on the fourth day.

Summary

High-grade calves in Tanganyika, even in the dry season, receive from their dams colostrum which is as rich in carotene and vitamin A as that yielded by Ayrshire cows in Scotland. Whilst the quantity of colostrum produced is probably smaller in the Mpwapwa herd, there is no reason to believe that high-grade calves receive an inadequate quantity of vitamin A or its precursor. Subsequent constitutional failures cannot therefore be correlated with deficiencies of these substances in the period immediately following birth.

TABLE

CAROTENE AND VITAMIN A VALUES OF COLOSTRUM

(Carotene as Yellow Units and Vitamin A as Blue Units per 100 ml.)

Heifer 261 (Pure-bred)			Cow 23 (Three-quarter Ayrshire)			Heifer 265 (Three-quarter Ayrshire)			Heifer 266 (Three-quarter Ayrshire)			Heifer 278 (Three-quarter Ayrshire)		
First Calf			Third Calf			First Calf			First Calf			First Calf		
Hours after calving	Carotene Y.U./100 ml.	Vitamin A B.U./100 ml.	Hours after calving	Carotene Y.U./100 ml.	Vitamin A B.U./100 ml.	Hours after calving	Carotene Y.U./100 ml.	Vitamin A B.U./100 ml.	Hours after calving	Carotene Y.U./100 ml.	Vitamin A B.U./100 ml.	Hours after calving	Carotene Y.U./100 ml.	Vitamin A B.U./100 ml.
2	325	1,060	2	560	1,090	3	437	1,162	2	260	770	4	740	810
17	436	725	19	735	652	10	560	560	11	148	945	13	780	596
24	292	577	27	689	723	27	330	790	26	136	677	28	500	495
39	283	444	43	730	564	34	255	562	35	98	425	37	400	395
48	253	426	51	670	495	51	290	325	50	56	325	52	200	275
63	159	310	67	590	455	68	157	365	59	46	220	61	170	170
72	66	186	75	460	390	75	80	285	74	39	189	76	130	100
87	67	143	91	340	495	82	85	245	83	31	141	85	79	87
96	54	89	99	210	375	99	78	185	98	26	117	100	61	70
111	37	76	115	180	270	106	50	100	107	18	120	109	50	62
—	—	—	—	—	—	—	—	—	—	—	—	124	49	50

(*Received for publication on 4th February*, 1941)

TO PREVENT SANDBAGS, SACKS AND HESSIAN FROM ROTTING

A simple method of rot-proofing sandbags, sacks and hessian is described by Dr. C. J. Magee, Acting Chief Biologist of the Department of Agriculture.

The treatment consists of dipping the bags in a preserving solution, wringing and drying them. (For use of the farm, about one-eighth or one-quarter of the quantities given below should be ample.)

The method is as follows:—

Dissolve 10 lb. of bluestone (copper sulphate) in 35 gallons of water in a wooden vessel—not one of iron or galvanized iron. Either put the crystals in a bag and suspend it just below the surface of the water overnight, or dump the bag up and down in a few gallons of hot water until dissolved, and make up to 35 gallons.

Dissolve separately in another vessel 11½ lb. of washing soda crystals (or 4½ lb. of soda ash) in 5 gallons of water.

Then, while stirring, add the soda solution slowly to the bluestone solution. Add a wetting agent, for example, Wetsit or Agral 3, and stir the mixture well. (If a wetting agent is not procurable, merely increase the time of treatment.)

Immerse the sandbags one by one until the fabric and stitching thread are thoroughly wet, which may take up to five minutes. Also dip the twine which will be later used for sewing the bags. Take out the bags and remove the excess liquid by running through a clothes wringer or mangle. The bags are then ready for immediate use or they may be dried and stored.

The Agricultural Gazette, New South Wales, Vol. LIII, Part 4, p. 172 of 1942.

NOTES ON AGRICULTURE IN ETHIOPIA
PART I

By Major F. de V. Joyce, M.C.

In October, 1941, Major Joyce was appointed temporary agricultural adviser to the D.C.P.O., Ethiopia, with instructions to tour the country for four months and report on agricultural problems, more particularly as they affected (*a*) food for the troops, (*b*) food for the civilian population, and (*c*) the future of Ethiopia. Owing to the local conditions at the end of 1941 his report deals almost entirely with (*c*). The following extracts from it are published with the permission of the C.P.O., East Africa Command.

In the course of his tour, Major Joyce covered over 5,000 miles and saw something of the following provinces and districts:—Tigre, Wallo, edge of Danakil, Shoa (including Salale), Gojjam (including Agaumeder), Gurage, Jimma, Kaffa, Harar (including Chercher), Wollamo, Sidamo, and the edge of Arussi, as well as some of the low country in the valleys of the Rivers Abbai, Omo, Gojjeb and Awash. He notes that the chief omissions were the neighbourhood of Tichio in the Arussi country and the high-rainfall area of the "Sudan Slope".

It will be noticed that there are differences between Major Joyce's spelling of some of the place-names and that in the map, which has kindly been prepared by the East African Survey Group. The spelling of names in Ethiopia has not yet been fully standardized and it has been decided not to alter either.

Ethiopia depends and will continue to depend almost entirely on agriculture for its prosperity. From an agricultural point of view it is one of the richest countries in the world, with immense variations of altitude and climate, deep rich soil, and, except for certain well-defined areas, ample rainfall. Serious droughts appear to be unknown, but periodical locust infestations occur.

Under conditions existing in Ethiopia, more particularly in regard to its inaccessibility from outside markets, and indifferent internal communications, I believe it wise to aim at making the country as self-supporting as possible. Imports and exports prior to the Italian occupation are given in an Appendix. Only high-value commodities will stand export transport costs.

Objects of an Agricultural Policy

The objects to be achieved are:—

(i) The maintenance of the population at as high a standard of living as possible in regard to the daily essentials of food, clothing and warmth.

(ii) Provision of funds, by export, to pay for such commodities as will have to be imported. An important corollary of this is to reduce imports to as low a figure as possible and restrict them to essentials, especially in time of war.

(iii) The provision of part of the revenue required for government services.

Generally speaking the peasant farmer in Ethiopia knows his job and does it extremely well. The chief essentials for the achievement of our objects are the conservation of the country's natural assets: soil, grass, forests and water, and a peaceful administration without unduly high taxation.

In very round figures Ethiopia comprises some 400,000 square miles and, with a population of about 8,000,000, has a population density of only 20 to the square mile. The proportion of arid unfertile country is small and, though in certain areas the population is dense, there is, taking the country as a whole, no question of shortage of land. There is in fact room for considerable expansion of human and animal population, in which respect Ethiopia can count herself fortunate.

It should be remembered that I was in the country during the dry season only. In fact, I only saw rain twice in October and not even a shower from November till I left Addis Ababa in February. In spite of this crops were in all stages of growth from newly germinated to newly harvested, often alongside each other, at the same time.

Though all aspects of agriculture are inextricably interwoven, I will deal with them for the sake of clarity under a number of main headings. This will result in some repetition which cannot be helped. Please remember also that there are many parts of the country that I have not seen and to which some of my remarks are inapplicable.

The headings will be as follows:—

Natural features:—(*a*) soils, (*b*) water and rainfall; (*c*) grasses, (*d*) trees and forests, (*e*) wild life;
Live stock;
Food crops;
Plantation crops;
Soil conservation;
Communications, transport and power;
Agricultural industries;
General.

Natural Features

Soils

The soil is generally of volcanic origin, contains no sand and is very permeable to water.

Along the northern edge of the country, as well as in parts of the main river valleys, it is shallow and lacking in humus and this applies to most of the Danakil and the borders of Somaliland. But these areas are a small fraction of the whole and in all other parts which I visited the soil was deep and rich.

There is much of the black-cotton type. For instance, astride the roads from Addis Ababa to Jimma, between Sabata and Wolisso, there are at least 200 square miles of nearly flat rich black-cotton soil in one block at an altitude of about 7,200 feet. On the whole there seems to be more deep rich red loam than any other kind. Some of it is interspersed with loose rock, but seldom sufficiently to interfere with cultivation.

Water and Rainfall

This is one of the best watered countries in Africa. It has many rivers and streams and innumerable springs. So well watered is it that I have seen good grazing left untouched because the nearest water was three or four miles away.

Where surface water is not available it is generally to be got in shallow wells, even on or near the hill tops. Even in the purgatorial country round Duanle on the border of French Somaliland, where it looks as if it never rained and nothing could grow, plentiful supplies of water are found at depths of 20 feet to 40 feet. I see no immediate necessity for a water-development programme, but every encouragement should be given to the type of very small earth dam which the peasants made in the flat plains, such as I have seen alongside the Fiche road. These are nothing more than small banks three or four feet high and four or five feet wide and throw the water back several hundred yards.

The time may come when it may be necessary to consider water development in hitherto unpopulated or depopulated parts of the country, but so long as the soil, grass cover and forests are safeguarded from avoidable denudation, the water position will look after itself.

Irrigation is practised on a small scale. There are some useful small water furrows in Chercher and also in Gojjam. Some of the latter are long and well laid out and are used for irrigating small fields of cereal and other crops. Those in Chercher are mainly for leading water on to small plots of "Khat" (*Catha edulis*), coffee and vegetables. This irrigation is entirely of native origin and quite unconnected with the Italian occupation.

The question of large-scale irrigation projects need not be considered at present, but the time will come when a survey should be made of the possibilities of turning to better use the enormous quantities of water that disappears in the Danakil depression and Lake Abbe in the north and Lake Rudolf in the south. When the time comes to explose those possibilities it will be well for the Government of Ethiopia to seek the best possible advice from some irrigation engineering firms of high standing. The advice and survey of such a firm may be expensive, but it will be much cheaper than embarking on an unsound large-scale irrigation project.

Most of the following figures are taken from the 1941 Handbook of Ethiopia, from which further particulars on temperature, etc., are available.

The greater part of the Ethiopian plateau over about 6,500 feet has a rainfall of over 47 in., as shown in Appendix II.

Grasses

The Handbook of Ethiopia gives the main grasses as species of *Panicum, Andropogon, Pennisetum, Eragrostis, Sporobolus, Aristida, Setaria, Paspalum, Chloris, Eleusine, Poa,* and *Festuca.* There are also 22 kinds of clover.

Generally speaking, except for sheep, the high-country pasture is not as good as that at the medium and lower levels. An exception to this is found in parts of Gojjam, where, from the Fettam River to Engiabara, at 8,000 feet there are large stretches of thick star grass (*Cynodon*) and consequently large herds of cattle and horses in good condition. The star grasses thrive from 3,000 feet to 8,500 feet. One of the best bits of cattle pasture I saw was on the plain south of Alomata, at 4,500 feet, thick, and rather ticky star grass. There were no cattle to be seen, but that was probably due to disturbed conditions existing at the time.

I noticed a good deal of small white clover at Amba-Alagi, between 9,000 and 10,000 feet, but not higher.

At the lower levels round Jimma and Lechenti the predominating grass is one of the

pennisetums, which appears to be readily displaced by star grass on old cultivation and when heavily grazed. I also saw here and there patches of Kikuyu grass (*Pennisetum clandistinum*) between 8,000 and 9,000 feet.

In the Rift Valley, along Lakes Zwai, Langana, Shala, in spite of very large herds of Arussi cattle, and a grey volcanic ash soil, there are only small areas of star grass and the rest of the pasture is indifferent.

Of exotic forage crops lucerne grows very well in the red soil at Harar and Jimma, at something under 6,000 feet, and no doubt would do well over a large range of the red soils.

Except round the larger towns, where there is a ready market for it, little hay is made or stored for forage, though I saw some stacked near Macalle for this purpose.

Except in the semi-arid areas the grass cover is thick, and, owing to the comparative absence of thorn scrub and good distribution of water, it suffers little from cattle tracks.

I saw little grass-burning, except in the low, hot valleys of the Omo and Billati (north of Lake Margherita) and I should not advise any attempt at present to check this practice in such areas as it may well result in controlling not only scrub but also tsetse fly, which exists in the lower parts of the Omo Valley.

Beyond encouraging hay-making from natural grasses no steps need be taken at present about this all-important crop. There is no need to import exotic grasses and if in due course a few dairy farms are established near the main towns that would be the opportunity for selection and improvement of existing kinds.

Trees and Forests

For its size, Ethiopia is short of timber. Enormous areas of the highlands are practically treeless and in these areas there is an urgent need for a vigorous tree-planting policy. Excessive water run-off will be controlled so long as the grass cover is maintained, so the main object of tree planting should be to provide building poles, timber, and fuel. In this way there will not be an undue tendency to cut out the existing forests, and the enormous quantity of cattle manure which is now used as fuel will be available for maintaining soil fertility.

If the trees planted can provide some outside source of revenue so much the better.

The greatest care should be taken to prevent the existing forests from being over-exploited. With care they should provide most of the building timber required in the country, but they will never provide timber for export.

The forests that I saw included those in Caffa, in Chercher, round Jimma and Lechemti and on the escarpment east of Dalie. All of these had saw mills in various states of dilapidation, and if and when these mills are put into working order again advice should be sought on the best methods of control.

There are also some extensive Acacia forests in the Lakes area of the Rift Valley, in the valleys in the Gojjam, and elsewhere, but there is a notable and welcome absence of small thick scrub and I saw not one single specimen of the "whistling thorn", except near Mega on my way back to Kenya.

The main forests include *Podocarpus*, cedar (*Juniperus procera*), olive (*Olea*), *Cordia*, cape chestnut (*Colodendron*) and many species of fig.

Another form of forest exploitation which must be guarded against is overtapping for wild rubber. The Caffe forest round Bonga contains a number of rubber-bearing trees and vines, notably various kinds of figs (especially *Ficus Sycamorus*), a number of Euphorbias and the *Landolphia* vine.

The natives have little sense of the value of trees. I saw many small podos ring-barked to kill them for firewood. On the other hand in the same area—Chercher—a few natives had planted some podos round their huts.

They preserve the beautiful tree *Brayera anthelmintica*, or Kosso, which grows to perfection at the higher altitudes and provides from its seeds* the monthly dose for tænia.

The Italian tree nurseries at Adigrat, Jimma and Harar had the usual varieties of exotic trees, including cypresses, pines, gums (*Eucalyptus*), pepper, *Casuarina*, *Acacia linifolia* and a willow. Except for gums, which the Ethiopians have been growing for years, I saw no plantations of these experimental trees.

Some of the towns, villages and farms in the high treeless area, such as Addis Ababa, are entirely dependent on gum trees for fuel and

* According to the British Pharmaceutical Codex, from the "fertilized flowers" the tree, familiar at high altitudes in East Africa under the name *Hagenia abyssinica*, will, it is understood, in future, according to the International Rules for Botanical Nomenclature, be called *Hagenia anthelmintica*.—Ed.

building poles. Only one species, the Blue Gum (*Eucalyptus globulus*) is used, which is useless, I understand, for milling into scantlings.

I advise that in these treeless areas Black Wattle be given a trial. It can be planted at stake (i.e. no nurseries required), grows about as quickly as the gums, makes better poles and firewood and has the great advantage of providing a possible source of revenue in its bark for tannin. In due course a tannin extract factory might be put up which would obviate the difficulties of transport in exporting the baled bark. Apart from this it would supply material for the existing tanneries and so avoid having to import it.

In addition to starting Black Wattle, I suggest a trial of gums. There are over 100 species of *Eucalyptus* and their use ranges from cabinet making to boat building. The Forestry Department of New South Wales would no doubt supply useful information, and if plantations of suitable milling species could be established near Addis Ababa it is conceivable that in a period of years the transport of sawn timber scantlings from far-distant forests could be eliminated.

Wild Life

Big game has been practically exterminated, and in view of the quantity of arms and ammunition distributed among the population it would be impossible to stop the process.

I suggest, however, that an attempt be made to preserve one or two of the rarer animals, such as the Mountain Nyala of Arussi, and that the sale of ivory be strictly controlled. I also suggest a heavy tax on colobus monkey skins to preserve this beautiful animal.

Game birds are plentiful. There is very good duck and snipe shooting, as well as guinea fowl, francolin, sand-grouse and bustards. Apart from their aesthetic value, these birds will have a "tourist value" in the future, and I suggest a bird-shooting licence be brought in.

Fish.—I got little or no first hand information about the fish existing in the various lakes. The important thing is to realize the great value from a nutritional point of view of all edible fish to the native population and to see that all possible use is made of it without impairing the supply.

In some of the highland streams Rainbow Trout should be introduced and protected. This will produce some direct revenue from licences and ultimately a more important indirect revenue from "tourist value".

Live Stock

Cattle are of the humped type and disappointing both in numbers and quality. There are not enough to maintain soil fertility or to provide sufficient meat or milk for the people. Dairy produce is practically unobtainable. I did hear of one political officer who, after doing some small favour for a local chief, was able to buy fresh milk from him daily, but when the chief's second request for help was unavailing, the cow died.

As one might expect, the low-country cattle look best. There are, however, some exceptions to this and it is noticeable that within a reasonable radius of a good meat market, such as Addis Ababa, the bullocks are in better condition than in similar country further away. This is presumably due to feeding for market.

The value of cattle to their owners appears to depend on their use in the plough and as meat. Milk and ghee seem to be incidental and are hardly considered at all in the highlands, where it is unusual to see a cow in good condition, though many of the plough oxen, as well as a few steers, are magnificent animals. The proportion of cows and heifers in any herd of cattle is very small.

Some of this apparent shortage of cattle, especially alongside the roads, is undoubtedly due to the unsettled state of the country, as well as to the fact that large numbers were used by the armies of both sides during the recent campaign. I think it is generally fair to say that the natives of the high fertile uplands give first place in their farming operations to crops of all kinds and it will take years of education to make many of them realize that their cows should provide a daily harvest that is better for them and for the land than the vast areas of cereals they now grow.

The only large herds of cattle I have seen were in Wollo near Goram, at the edge of the Arussi country near Lake Zwai, on some of the sour flats near Jimma and, to a lesser extent, in Gojjam.

There are far too many bulls in the herds and no selection seems to be exercised. I advise that steps be taken to select the best bulls and eliminate the others by castration. This would not be difficult nor do I believe it would be unpopular.

The condemned rate for measles in beef bought for the army works out at about 15 per cent in Addis Ababa and only 4 per cent at Jimma; the standard of inspection being the usual one as applied to meat for the troops in Kenya.

The usual African cattle diseases exist: rinderpest, pleuro-pneumonia, anthrax, blackleg, anaplasmosis and redwater. I could get no reliable information about east coast fever, but think most of the country is free of it.

Tsetse fly occurs in parts of the Omo and Gojjeb valleys and no doubt elsewhere. Large areas of the "Sudan Slope" round Gambeila are also infected.

Ticks are few in the high, cold country. In the Gojjam, where the cattle were very tame, I closely examined a large number of cattle in two herds and did not find a single tick on them.

Having seen the dangers of overstocking resulting from an energetic policy of veterinary disease-control in other countries, I see no need for making the same mistake here.

The present shortage of cattle in many parts of the country should be overcome by gradual education in the value of live stock as well as, one hopes, by peace and security. No "quarantines" for cattle diseases are necessary or could be enforced. They would only be an irritant and a hindrance to trade and not achieve their object.

It is doubtful whether an attempt should be made to control even rinderpest. So prevalent is this disease that considerable immunity must have been built up. Native cows can be bought with the seller's guarantee that they have had rinderpest and are therefore immune, though naturally no guarantee is asked for in the case of an animal bought for slaughter. In any case a campaign for the complete eradication of rinderpest will be impossible for many years to come.

I therefore advise that no steps be taken at present for the control of any cattle disease. If at some future date it is found desirable to control disease in any special herd of cattle, such as on the proposed dairy farms I refer to below, it will be cheaper to get the necessary material by air from Nairobi or Asmara than to maintain an expensive serum- and vaccine-producing laboratory in Addis Ababa.

This advice may appear to be retrograde and will no doubt be condemned by some modern veterinarians. Under conditions obtaining in Ethiopia and some of the adjacent territories, I nevertheless believe it to be sound.

I would not close down the veterinary laboratory at Addis Ababa as a place for diagnosing such diseases as yield to examination by microscope, or as a source of supply, on payment, of imported drugs and vaccines for the treatment of valuable animals. The means of diagnosing, for instance, tick-fever (piroplasmosis) in horses and rabies in dogs should remain available. Private veterinary practitioners should be encouraged; but this is all quite distinct from any attempt by Government to initiate a scheme for general control of cattle disease. Any such scheme, if successful (which is unlikely) will at the present stage of the country's development, and for many years to come, only do harm.

In view of the shortage of milk, butter and cheese, I suggest that a few dairy farms be established near some of the larger towns. A start might be made near Addis Ababa with one farm and, at this stage, I advise that it be a Government farm with a first-class European manager. The details of such a scheme would require careful thought and its object should include not only the supply of dairy produce to the town, but also—

(*a*) a school of instruction for potential native dairy owners; and

(*b*) a source of supply of selected bulls.

The best native cows give only half a gallon of milk a day and an average good one about a quart. Most of the native cows I have seen would not give a pint a day.

It should be perfectly feasible to breed up a native cow in 10 years time that would yield an average of one gallon a day on these dairy farms with proper care and feeding, and for the first few years anyway I would not introduce European bulls. Even then, if more rapid increase in milk yields were required, it would probably be better to import the highly productive sahiwal Indian bulls of Zebu type.

Hides and skins are one of the country's main exports. The annual average export for the 10 years up to 1934 amounted to roughly 6,000 tons of hides and 1,200 tons of skins. Except for those dealt with by the larger butchers, most of these hides and skins are badly cleaned and sun-dried and enormous loss of value results. As soon as an export trade in hides is re-established the Government should issue orders that all skins and hides be shade-dried and see that they are carried out.

The Government could no doubt arrange with the principal hide merchants for the training of instructors in the details of correct hide preparation.

Sheep.—These consist of mixed native types and are generally in good condition. They

appear to do best on the very high country round 10,000 feet, but I saw a good small, nearly white flock at Batie on the edge of Danakil country at about 5,000 feet and another good flock of black-headed Somali sheep at Jigjigga at about the same altitude. There are a few slightly woolled sheep in the high country round Debra Berhan, known as Manze, and the natives spin and weave their wool for cloaks. There is an Italian Government farm a few miles north of Addis Ababa on the Dessie road, where some very fair Romney Marsh and Merino crosses were bred. I suggest the ram lambs now about three months old be left uncut and, when big enough, be distributed free, together with all the other rams, or sold cheap, to sheep owners in the districts referred to above and that the balance of the flock be sold and the farm closed. If the resulting improvement in wool were appreciated by the local cloak makers, the suggested dairy farms might be used for producing an annual crop of low-grade (half-bred) rams for further distribution. No attempt should be made now to raise high-grade woolled sheep, though I have no doubt but that the high-grade sheep would do well at high altiudes under a good flock-master.

Goats.—Fortunately are comparatively few in number.

Camels.—These I have only seen round Macalie, in Danakil and on the East Somali Slope.

Horses, Mules and Donkeys.—Abound everywhere and all will be of increasing value for transport as the roads deteriorate. In this mountainous country they will be the only practical means of transport for an indefinite period in many districts.

Mules are more highly valued than horses both for riding and as pack animals. The best ponies I have seen were in Gojjam but, as in the case of cattle, more discrimination should be used in selection of sires.

Horse-sickness exists in certain areas, but losses are not great. Lymphangitis and tick-fever also occur.

Pigs.—I have seen a few only and, considering they lived on what they could pick up in the stubbles, they were in fair condition. The Army was able to buy limited supplies of pork which was said to be of fair quality.

An increase in the pig population is to be encouraged in the interests of more varied food for the small farmer.

Poultry.—Widely distributed, poor quality; but eggs are easy to obtain. In due course some improved types should be imported from adjacent countries and distributed free in order to improve the size of both birds and eggs.

Bees.—The wild bee supplies one of the larger items of export, amounting to about 400 tons per year of beeswax. So important is their honey for the manufacture of the universally drunk mead or "tej", that no further inducement is necessary for the development and maintenance of this form of "live stock".

Food Crops

General

The standard of cultivation is very high. In spite of the primitive plough used, a wooden one with an iron or steel point, which takes two oxen and one man only, preparation of land, though not deep, is very thorough and no change in type of plough or methods should be encouraged.

Ploughing is done on the contour, the land left rough and cloddy, which helps to control wind and water erosion and the consolidation of soil is done by the first heavy rain after sowing. There is no mixing of crops in the same field as is seen in many other parts of Africa.

A system of crop rotation is generally practised, but as at least 80 per cent of the crops are cereals it is inadequate. Near the large grain markets, such as Addis Ababa, the standard of farming deteriorates. More cereals are grown and less trouble taken with terracing, draining and strip cultivation.

I saw no attempt at manuring, even where there was plenty of firewood and cattle dung was not used for fuel, but some fertility is returned to the soil by grazing the stock on the stubbles, more especially on the tef stubble. As in all countries some of the peasants are good farmers and some bad, but there is no doubt from the tidiness of the farms (as opposed to the towns) that the average peasant farmer, whether he be Amhara, Galla or anything else, is deeply attached to his land and gives it much thought.

In the Lechemti area a number of farmers fold their cattle at night in small temporary bush enclosures on their stubble, and these enclosures are moved every few days till the whole field has been thoroughly well manured. Their example might well be followed by many European farmers.

(*To be continued*)

PRESERVATIVE TREATMENT OF EUCALYPTUS FENCE POSTS

By S. H. Wimbush, B.A., Dip. For., Assistant Conservator of Forests, Kenya

Fence posts of Blue Gum (*Eucalyptus globulus*) and Saligna Gum (*E. saligna*) treated with a 2 per cent solution of Wolman Salts are still in good condition after standing seven years in proximity to an active termite nest in red coffee soil near Nairobi. Untreated posts of the same trees were attacked by termites within a short time after placing in the ground, and after three years were no longer serviceable as fence posts.

Untreated fence posts of Lemon-scented Gum (*Eucalyptus citriodora*) lasted longer than untreated Blue Gum and Saligna Gum posts, but were considered unserviceable after five years in the ground. Posts of Lemon-scented Gum treated with Wolman Salts are still in good condition after 10 years in the testing ground. Blue Gum and Saligna Gum fence posts which were allowed to season for three months after felling before treatment with Wolman Salts have given better service than posts treated directly after felling. These unseasoned treated posts are less sound below ground and the tops of the posts have more splits than the posts which were seasoned before treatment.

Method of Treatment.—The posts were treated by the so-called "Open Tank" method, and the preservative used was one of the "Wolman Salts" (Tanalith U) made by Messrs. Hickson and Welch, Ltd., Castleford, England. The preservative was used in the proportion of 1 lb. of salts to every five gallons of water; this makes a 2 per cent solution, viz. two parts by weight of preservative to 98 parts by weight of water.

The method of treatment is as follows:—Stand a 40-gallon drum (with one end cut out) on end, supported on stones so that a fire can be made underneath. Fill the drum about half-full with water; light a fire under the drum. When the water is very hot, add the preservative salts in the proportion of 1 lb. of salts to every five gallons of water. Stir well until the salts have dissolved. Stand as many barked fence posts in the drum as it will hold (generally 6–10 depending on size). Keep the water very hot (but not boiling) for five hours. Then rake out the fire, and leave the posts to stand in the cooling solution for 17 hours. At the end of this time take them out, and give the top (untreated) part of the posts a good brushing with the cold solution in the drum.

The posts will have absorbed four or five gallons of the solution, so before a fresh lot of posts are put into the drum water must be added and also the right amount of preservative salts in the proportion of 1 lb. of salts to five gallons of water. The drum is then heated up again, the solution well stirred when it is very hot, a fresh charge of posts put in, and the treatment continued as before. With five hours hot and 17 hours cooling, that leaves two hours in every 24 hours for taking out the treated posts, re-heating the drum, and putting in the new posts. If a lot of posts are to be done, it pays to have two or three drums going at once; they can all be looked after by the same boy.

A freshly felled gum post generally absorbs less than half gallon of solution during the treatment. A seasoned post absorbs rather more than half a gallon. The cost of treatment with Wolman Salts at Sh. 2/50 per lb. (the pre-war price) works out at cents 20 to cents 25 per post, including labour wages and cost of firewood, but not including the cost of the drum.

The suppliers of Wolman Salts in Kenya are Messrs. G. North & Sons, Ltd., Hardinge Street, Nairobi.

(*Received for publication on 4th September,* 1942)

IMPROVISED TREK CHAINS

By B. R. D. Eccles, Agricultural Assistant, Tanganyika Territory

"Chains" made from hippo hide

It is probably not widely known that excellent improvised trek chains for short teams of 4–6 oxen can be made from hippo hide.

Strips 2 in. wide and from 7–8 feet long (according to size of oxen) are cut from the heaviest part of the hide, i.e. the back. The strips should be cut so that they are slightly wider at the ends and an eye is cut in each end; do not cut the eyes too near to the ends, but about 1 in. to 1½ in. back.

To join two or more "chains" together hardwood or iron toggles are used. The back eye of the front "chain" is passed through the front eye of the after chain and the toggle is then slipped through the eye of the front chain. The yoke traces are also passed through the eyes.

For four oxen one can cut a continuous chain, if preferred, by cutting a circle round the hide as is done in reim making. Eyes are then cut at each end and in the middle for the traces. D shackles are used by some people for connecting, etc., and are more satisfactory.

These "Trek Chains" are most satisfactory and last well. I have never tried using them with more than six oxen, but they might be strong enough for eight of the lighter type of beast found in East Africa.

It should be mentioned, too, that traces for donkeys, mules and horses can also be made from hippo hide. They have the advantage over chains that they are less liable to chafe.

"Chains" made from old wire cables

Good trek gear can also be made from old wire cables, suitable lengths being cut and an eye splice being put in at each end. D shackles are used for connecting.

The splices should be covered with raw hide, otherwise the ends will cut the oxen.

As cable splicing is difficult and a job that very few people are capable of, an alternative method of forming the eyes is worth mention.

Find some old pipe of a diameter which will just take two thicknesses of the cable available. Cut the pipe into 7-in. lengths and slip two lengths on to each length of cable. Now bend back one end of the cable to form an eye and slip one of the pieces of pipe over the doubled cable. Adjust till an eye of the required size is formed. Stop one end of the pipe with stiff clay and pour molten sulphur or lead into the open end. Allow to set and then repeat the operation at the other end of the cable. Trim off any odd ends of cable and the "chain" is ready.

SISAL ROPE "TREK CHAINS"

By J. E. Peat, Agricultural Officer, Tanganyika Territory

At the request of the Director of Agriculture, sisal rope "trek chains" have been tried at Ukiriguru, in the Lake Province of Tanganyika Territory, for the past few months—through the dry season: they might wear more quickly in wet weather. In view of the difficulty of getting trek chains, the results should be of some general interest. They have been in continuous use on single furrow E.C.A. ploughs, ploughing in heavy black soil, and on dam scoops levelling on coarse sandy soil. There is no doubt about their capacity to take the strain. They have had a fairly hard testing. They stand up to wear at the point of attachment very much better than anticipated.

Lengths of 12 feet were cut from 1 in. diameter 3-ply sisal rope; 18 inches were sliced back simply at each end and tied, giving an effective 9-foot trek rope, with an eye at each end.

One rope was used direct on to the plough and yoke fastenings, without any cushioning. It stood up to 2½ months' work before it gave at the eyes. Had the eyes been protected with any simple cushioning, sacking or reim—which would be replaceable when worn—it would have lasted considerably longer.

A second rope was used round a wooden block four inches in diameter, held at each end in an iron U, secured to the plough and yoke fastenings. This was to reduce wear at the point of attachment. The rope slipped about on the wooden block—though this could have been prevented by grooving it—and wore against the holding U. It wore out at the eyes in 2½ months' work.

A third rope was fitted at each eye with a pear-shaped iron "thimble", for use with a 1 in. diameter rope. The wear at the point of attachment was thus considerably lessened, the direct pull being on the iron "thimble". This trek rope was in continuous use for nearly four months before the first eye gave: the second eye was only partly worn. When the rope does give the "thimbles" can be transferred to a new length of rope. This is probably the most satisfactory fitting and certainly the simplest. But a simple cushioning of the eyes at each end of the trek rope would probably be satisfactory.

NOTES ON ANIMAL DISEASES

XVII—MISCELLANEOUS DISEASES CAUSED BY BACTERIA

Compiled by the Veterinary Department, Kabete, Kenya

Tuberculosis

Fortunately in Kenya and Tanganyika Territory tuberculosis is a rare disease of cattle and only occasional outbreaks are reported in pigs and poultry. In Uganda, tuberculosis of the Ankole longhorn breed is relatively common. In the Nairobi Abattoir isolated cases of tuberculosis in Masai cattle are discovered from time to time by the Meat Inspector. In these animals the lesions are usually limited to "grapes" on the peritoneum and to local lesions in the adjacent lymphatic glands. Very rarely the lungs and associated glands are involved.

Outbreaks in grade stock are very rare, but when they do occur cases show a much greater resemblance to the classical disease as seen in Europe. There is loss in condition with, usually, coughing and other signs of lung infection. Tuberculous mastitis has not been seen. The open-air conditions under which cattle are kept on most farms militate against the rapid spread of infection.

Tuberculosis of cattle is a disease under the Kenya Diseases of Animals Ordinance, 1905. Outbreaks in grade cattle are notifiable and rigorous measures are taken to suppress them. Amongst Masai Zebu stock the disease shows little tendency to spread and eradication would be impossible, except by tuberculin-testing the whole cattle population of the Reserve.

Johne's Disease

Johne's disease is a disease of cattle, and more rarely of sheep, caused by a bacillus related to the tubercle bacilli. It is the cause of great economic loss in European dairy herds; but fortunately is not often seen in Kenya. A few outbreaks have, however, been diagnosed on the Kinangop and on the Uasin Gishu Plateau, and what appear to have been isolated cases have occurred on farms in other areas.

Symptoms.—The disease is characterized by chronic diarrhoea and wasting. The cattle develop a very persistent form of diarrhoea, the faeces becoming brownish-green in colour and watery in consistency. There is very marked loss in condition and eventually the animal dies.

Post-mortem Lesions.—Except for emaciation there are no lesions to be found other than those in the gut and associated glands. The early part of the small gut is usually normal; but the latter half and a variable length of the large bowel is found to have a thickened mucous membrane. The thickened membrane becomes wrinkled, there is usually little congestion and ulceration does not occur. In advanced cases, the lymphatic glands in the "skirt" may be slightly swollen and oedematous; but they show no cheesy foci, such as are found in tuberculosis.

Diagnosis.—The confirmation of diagnosis during life is almost impossible except in certain advanced cases, and hence the control of an outbreak is difficult. In cases where the mucous membrane of the rectum, within reach of the anus, is infected, it is possible to remove a small piece of mucous membrane and demonstrate the presence of the causal organism in smears. This portion of bowel is, however, not constantly involved.

An extract of the causal organism prepared in a manner similar to that used for preparing tuberculin has recently been elaborated, but extensive tests of this product, both in England and at Kabete, have shown that even in its most recent and most purified form it produces many false-positive reactions, and it is therefore quite unsuitable for use in the control of the disease in Kenya. The organism is notoriously difficult to cultivate on laboratory media and small laboratory animals are not susceptible to inoculation.

Control.—All animals showing symptoms suspicious of Johne's disease should be isolated in a stable and the manure from the stable should be burnt. Since it is most unusual for cases to recover temporarily one is fairly safe in assuming that an animal that recovers when shut up and fed is not a case of Johne's disease.

Calves with worms and cows with chronic septic metritis (infection of the womb) may show chronic diarrhoea persisting for a week or longer; but other cases of chronic diarrhoea in cattle are usually Johne's disease.

Bovine Lymphangitis

Bovine lymphangitis is a disease of cattle caused by the specific organism *Actinomyces farcinicus.* It is an uncommon disease in Kenya and is only known from the Uasin Gishu Plateau—Trans Nzoia area.

Symptoms.—Bovine lymphangitis is a chronic disease characterized by the development of subcutaneous abscesses and in the later stages by severe loss of condition.

Abscesses may be found under the skin of various parts of the body, but are most common in the region of the throat and neck or on the limbs. The abscesses are hard and do not burst spontaneously. Infection spreads via the lymph channels to the regional lymphatic glands and the walls of the lymph channels become thickened. But owing to skin-thickening, which also occurs, the cording of the lymph vessels is often difficult to detect during life. In advanced cases the lungs or udder may become involved.

On cutting the abscesses, they may be found to contain creamy-yellow pus or white cheesy material or, if connective tissue formation has occurred, the lesions have a firm capsule with usually a cheesy centre. The lymph vessels have thickened, fibrous walls and contain creamy or cheesy purulent material. Suppurating centres may be found in adjacent lymph glands.

Treatment and Prevention.—Surgical excision may be of assistance in the early stages, but recurrences are common and treatment is not usually of value. Infection occurs through skin wounds and the bites of ticks of the genera *Amblyomma* and *Hyalomma* are probably responsible for a number of cases. Dipping should, therefore, be practised and all infected carcasses should be burnt.

Kenya Actinobacillosis

During 1941, what appears to be an undescribed disease was observed in a herd of high-grade and pure-bred Friesian cattle near Nairobi. Symptomatically the disease was somewhat similar to bovine lymphangitis and an organism belonging to the same group as *Actinomyces farcinicus* was isolated. In all the cases seen the infection was restricted to the lymphatic glands of the throat. These showed hard, round swellings which had little tendency to rupture. On lancing, small quantities of a viscid, milky-white pus could be squeezed out. The swellings, however, consisted mainly of fibrous tissue through which ran narrow tortuous channels containing the pus. From the pus an organism related to but distinct from *Actinobacillus ligniersi* (found in "wooden tongue" of cattle in other countries) was obtained in pure culture.

Untreated lesions developed slowly and owing to their nature, lancing and treatment by dressing with ordinary antiseptics was of little use. Complete excision was, however, so successful that all cases were cured and it is not known whether or not the disease may ever terminate fatally.

Isolated cases of "wooden tongue and lumpy jaw" (actinobacillosis and actinomycosis) have been reported in Kenya, usually in imported stock, but they are exceedingly rare.

Lymphangitis of Horses

Two forms of infectious lymphangitis occur in horses in East Africa, ulcerative lymphangitis or cellulitis caused by a *Corynebacterium* (related to the diphtheria bacillus of man) and epizootic lymphangitis caused by *Cryptococcus farciminosus* (a peculiar organism related to the yeasts). Whilst ulcerative lymphangitis is still fairly prevalent, during the last ten years epizootic lymphangitis has become a rather rare disease in Kenya.

Both causal organisms are capable of a saprophytic existence in the soil from when they gain entrance to the body through small cuts and wounds. Clinical experience suggests that ticks of all species play an important part in the transmission of both forms of lymphangitis.

Symptoms.—In both diseases the characteristic symptom is the appearance of a small pus-containing nodule. Nodules may develop on any part of the body, but are probably most frequently seen on the hind limbs. They vary in size from that of a pea to that of a pigeon's egg. The nodules ulcerate and fresh nodules appear in the skin sometimes nearby, but occasionally at some distance from the original lesion.

In ulcerative cellulitis the skin and subcutaneous tissue in the neighbourhood of the lesion usually becomes swollen; but in a percentage of cases genuine lymphangitis, that is to say, a swelling or "cording" of the lymph channels occurs and fresh nodules develop along the course of the lymph channel. In epizootic lymphangitis "cording" of the lymphatic channels is more constant and infection frequently spreads to the regional lymphatic glands; but in this form, also, there is diffuse swelling of the subcutaneous tissue.

Cases of epizootic "lymphangitis" have been seen in mules in which the organism has gained entrance to the lungs and produced a pneumonia; but the majority of cases of both diseases are chronic. Occasionally the lesions remain localized; but eventually in most ani-

mals the infection becomes widespread and there is marked emaciation and death.

Animals Affected.—Among domesticated animals only equines are affected. Horses are more susceptible to ulcerative lymphangitis than mules, and this form probably never occurs naturally in donkeys. The mule is probably as susceptible to epizootic lymphangitis as the horse, and rare cases have been seen in donkeys.

Diagnosis.—A definite diagnosis can only be made from the microscopical examination of smears of pus from an unopened nodule. The causal organism of epizootic lymphangitis is easily recognized in smears, but the genus *Corynebacterium* contains many non-pathogenic organisms that may be found in pus from an open wound and which cannot be distinguished microscopically, either from each other or from the causal organism of ulcerative lymphangitis.

Treatment.—In neither form of lymphangitis is treatment hopeful. Surgical treatment or the local application of biniodide of mercury blister may lead to the healing of an isolated ulcer; but fresh lesions usually develop at other sites, sometimes several weeks after it appears that the case has been cured.

Recent experiments show that some early cases of ulcerative lymphangitis will respond to treatment with sulphapyridine (M. and B. 693), but at present such treatment is expensive and, if painful swellings are to be prevented, the inoculation requires great care.

Some workers have reported good results in the treatment of epizootic lymphangitis with the intravenous inoculation of biniodide of mercury dissolved in potassium iodide solution. It would appear, however, that no really satisfactory method of treating either disease is known.

Prevention.—Animals infected with either disease should be isolated and those seriously affected should be destroyed. Every horse on a farm should have its own grooming kit and it is worth while to adopt a routine system of washing brushes, curry-combs, sponges, etc., in a disinfectant solution once a week.

Horses should be well-groomed every day and all wounds, however small, should be dressed with a recognized antiseptic as soon as they are found. On farms where ticks are prevalent, every effort should be made to detick the horses daily. Few people realize that horses can be dipped in a cattle dip; but farmers who put their horses through the dip after their cattle are unanimous in their opinion as to its value in reducing the incidence of skin diseases and lymphangitis.

SCIENCE AND AGRICULTURE

It seems clear that the application of science to agriculture in the future will be on a wider basis than in the past. It will no longer suffice simply to know how a particular nutrient or treatment affects the yield; the effect on composition must be studied, and on the intrinsic and the market values of the crop and its reaction to disease organisms. Like everyone else, the chemist must specialize, and so he cannot be expected to become expert in a number of different species. But he must cultivate the art of working with other people. As the years go by this need will become more insistent, and success will go to those who have the gifts of co-ordinating the efforts of different scientific workers and of synthesizing into a coherent pattern the multitudinous fragments of truth that they succeed in finding.

Sir John Russell in *Chemistry and Industry.*

WRITE SIMPLY!

They said: "We are unaware as to what arrangements. . . . ."

Try: "We do not know what arrangements. . . . ."

They said: "The tablets had very high standard of disintegratability."

Try: "The tablets disintegrated very well."

They said: "If excess alum has been used in the coagulation, the resulting retardation of cure is pronounced."

Try: "If excess alum has been used in the coagulation, cure is much retarded."

The importance of the soil . . . . is paramount in the life history of nations. Disregard its care, and you pay; give it care, and it pays.

W. A. Rochie in *Geographical Review.*

REVIEWS

B. D. BURTT, "SOME EAST AFRICAN VEGETATION COMMUNITIES", Burtt Memorial Supplement, *The Journal of Ecology*, Vol. 30, No. 1, 1942.

This long-expected tribute to Mr. Burtt's enthusiastic studies of East Africa's vegetation, from which a cruel fate tore him so prematurely, has at long last appeared and one can only hope that the large number of copies which are said to be on the way will survive the "inconstancies of war" in order that these important contributions to our knowledge may be profitably enjoyed by as many as possible.

In a short foreword, Mr. W. H. Potts, his friend and fellow worker in the Tsetse Research Department, gives us delightful extracts from the young naturalist's diaries through which we obtain an insight into the trend and development of his work and thoughts during the thirteen years of his untiring field-work; and which "illustrate the manner of life he delighted to lead, and—more important—will give the background against which he collected the information contained in this paper". They fully reveal a mind which was, and remained to the end, that of a most loveable enthusiast and admirer of Nature in all her moods. . . . .

The difficult and delicate task of editing, in readable form, the great mass of notes and papers which fell to another co-worker, Dr. C. H. N. Jackson, has been very successfully overcome by a rearrangement whereby seven vegetation types are described along two transects through the Territory, one more or less north–south from Lake Victoria to Lake Nyasa, and the other in a south-easterly direction from Shinyanga to Morogoro. These accounts, mostly in Burtt's "own vivid and individual style", are strictly descriptive and free from successional speculation, and will, therefore, be a great boon to the eventual compilers of the much talked-about and fundmentally indispensible physiognomic vegetation map of East Africa.

Of the fifty-three pages given to these descriptive sketches one-quarter each are devoted to the two prevalent types, Miombo Woodland and Thorn Savannah, one-fifth to the Deciduous Thickets, one-eighth to Evergreen Communities, mostly riverine, and the remaining eighth are shared by combretum, Highland Grassland and Termite Mound Communities. The number of Miombo sub-types that Burtt has taught us to distinguish is astonishing and would, no doubt, have been further increased had his investigations taken him into the vast Miombo area of the sandstone plateaus in the Southern Province with their characteristic "bamboo–miombo" community. But I, who for many years have wandered and worked and surveyed in all Miombo types, cannot agree with the statement (p. 74) that "in full leaf the Miombo forest is delightfully cool and shady". In the contrary, I have always considered as one of the outstanding characteristics of these dry woodlands their relative shadelessness, due to the peculiar adaptations for husbanding the scant available soil moisture, which enable the trees to twist their leaves into a position parallel to the rays of the sun, in order to reduce transpiration to a minimum. In the Thorn Savannah types their obvious dependence on varying soil types, i.e. their edaphically determined distribution, is rightly emphasized.

The practice of throwing a great number of physiognomically very differing vegetation communities into a large covering group of "Deciduous Thickets" is not accepted by all, although it may, for the time being, form a convenient mantle for cloaking our as yet far from complete understanding. Such examples as primaeval Hill Thickets, River Gorge Thickets or Lake Cliff Thickets, etc., are indeed thickets in the true sense of the word, i.e. islands of denser growth in a surrounding sea of more open vegetation. But to group with them other forms which, like the Itigi and Mpwapwa "Thickets", though certainly "thick", dominate vast areas, seems to me linguistically wrong. However, this practice, largely I believe due to Swynnerton and Burtt themselves, is by now so firmly established in East Africa that it will probably prove impossible to free oneself from it. More serious is the omission of the Baobab from the descriptions of the *Commiphora-Cordyla*, and the Shinyanga thickets in which this tree forms so conspicuous, in places even dominant a component of vegetation and landscape alike! In fact, *Adansonia* is mentioned only once in Burtt's own compilations, and that only in connexion with a somewhat unorthodox occurrence in the riverine deciduous fringing forests of the seasonal rivers in Shinyanga. The reference to my own observations on the Itigi thicket (p. 110) is, I am afraid,

entirely misquoted: the change from *Commiphora* to Itigi thicket does not take place east of Dodoma, as the text infers, but a long distance to the west where the railway climbs the Saranda scarp and gets locally away from the granite and on to the "uricrusts" which harbour the Itigi thicket (*vide* my own exposition of my views in *J. Ecology*, 1936, No. 8, pp. 481/2).

The short notes on Termite Mound Communities are a welcome sign that botanists, too, are waking up to the paramount importance of these insects in the general ecological picture of Africa; and it is all the more regrettable that the author's untimely death has robbed us of the fuller account of these termite mound communities that he had begun to prepare.

After a long distribution list of nearly five hundred species, a short general discussion on distribution, presumably by Dr. Jackson, ends this most valuable contribution to our knowledge of the East African flora. And in this summary we are, at last, informed that Baobabs are common in the thorn country!

To everyone, but more particularly to the geographer anxious to grasp the physiognomic aspects of vegetation types in relation to the surface of the land, the fifty-two magnificent photographs are a pure joy; and one cannot be too grateful to the Swynnerton–Burtt Memorial Fund Committee and to the Editor of the Journal for having made their publication possible, in spite of the war, and in such a lavish, clear and artistic manner.

C.G.

LIST OF ECONOMIC PLANT DISEASES IN THE ANGLO-EGYTIAN SUDAN, by A. S. Boughey, B.Sc., Ph.D.

This publication will be of particular interest to agriculturists in the Sudan, and is a useful addition to our information on plant disease distribution in Africa. Besides many agricultural and horticultural crops, some weeds and ornamentals which may serve as alternative hosts for crop diseases are also listed. The booklet is compact in size and is published by the Department of Agriculture and Forests of the Sudan Government.

G.B.W.

MAMBO YA UKULIMA—Pamphlet No. 31 (printed by the Government Printer, Dar es Salaam. Price Sh. 1/50).

A book or pamphlet dealing with local agriculture has long been needed. This pamphlet is a translation into Swahili of a record of investigations and observations by three agricultural officers of the Tanganyika Government. While it deals mainly with the cultivation steppe of Sukuma (in the Lake Province of Tanganyika) and Unyamwezi (in the Western Province of Tanganyika) many of its findings can be applied to other parts of the Territory. As an agricultural text book for the use of native teachers or others concerned with the spread of agricultural knowledge, I consider that it is a much too literal translation from the English version. As a result of the many tabulated results of experiments it may be difficult to see "the trees from the wood". This criticism is borne out by two educated natives who studied this pamphlet. The material knowledge contained in the pamphlet is excellent and is what is wanted, but a native will, I think, find it difficult to obtain the information he requires without a lot of extremely difficult concentration (for him). In my opinion, it would have been better if the Swahili version of the report had been rewritten from the native point of view, using as a basis the excellent material resulting from the investigations and observations but omitting most of the experimental records which led to the conclusions.

A too literal translation has caused certain phrases to be used which are not generally used by the natives themselves, e.g. "miaka mikavu" for dry years; "mia chache za majembe"—a few hundred hoes. Incidentally a mistake has also crept in by a too literal translation; the appendix dealing with the making of compost is number 3 not 4 as stated on p. 18 of the pamphlet. It seems to me probably that this appendix was number 4 in the English version of the book, but the rearrangement of the appendices was made in the Swahili copy.

However, the pamphlet, especially those chapters dealing with the various crops and manuring, will be found to be well worth a careful study by those engaged in the drive to improve native agricultural practices.

D.W.